## First National Environmental Health Survey of Child Care Centers

## FINAL REPORT July 15, 2003

**Volume I: Analysis of Lead Hazards** 

#### Prepared for:

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#### **EXECUTIVE SUMMARY**

The First National Environmental Health Survey of Child Care Centers (referred to here as the CCC Survey) was conducted under the sponsorship of the Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), and the Consumer Product Safety Commission (CPSC) to assess children's potential exposure to lead, allergens, and pesticides in licensed child care centers that serve children under age 6 in the 48 contiguous United States. Lead levels were estimated in settled dust, paint, and play area soil; indoor allergen (allergy-inducing substance) levels were measured in settled dust; and pesticide residues were determined on indoor surfaces and in play area soils.

This report, Volume I, includes the findings for lead hazards and describes lead levels in dust, soil, and paint in the Nation's child care centers by the building's age, type, and geographical location, and population demographics. In addition, the report estimates the number and percent of child care centers with dust and soil lead levels above the thresholds in the EPA 403 rule, which HUD adopted in HUD's Lead Safe Housing Rule (24 CFR Part 35 et al., *Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance*, effective September 15, 2000).

#### **Lead-Based Paint Hazards**

The number of child care centers classified as having a lead-based paint (LBP) hazard depends on the definition employed in such classification. This report focuses on *significant LBP hazards*, defined in accordance with the HUD Lead Safe Housing Rule (24 CFR 35). If any of the following situations exist in a child care center, then a significant LBP hazard exists in the center under this definition:

■ Deteriorated LBP – LBP with deterioration larger than the *de minimis* levels per Section 35.1350(d) of the Lead Safe Housing rule, viz., deterioration of more than 20 square feet (exterior) or 2 square feet (interior) of LBP on large surface area components (walls, doors) or damage to more than 10 percent of the total surface area of interior small surface area components types (window sills, baseboards, trim). LBP is defined as any paint or other surface coating (e.g., varnish, lacquer, or wallpaper over paint) that contains lead equal to or greater than 1.0 mg/cm²; or

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- Lead-Contaminated Dust As measured by wipe sampling, dust on floors with greater than or equal to 40 μg/ft² lead, dust on window sills with greater than or equal to 250 μg/ft² lead; or
- Bare, Lead-Contaminated Soil Any bare soil with a lead concentration greater than or equal to 400 parts per million (ppm) in a play area.

The findings in the body of this report are based on this definition of a significant LBP hazard.

An estimated 14,200 or 14 percent<sup>1</sup> of licensed child care centers in the United States have significant LBP hazards. Centers in older buildings are more likely to have significant LBP hazards than those in newer buildings. An estimated 26 percent of centers built before 1960 have significant LBP hazards, as opposed to around 4 percent of centers in buildings built since 1978.

These percentages are lower than the incidence of significant LBP hazards found in houses. The National Survey of Lead and Allergens in Housing<sup>2</sup> found 25 percent of homes had significant LBP hazards. This percentage increased to 54 percent among homes built before 1960. These estimated 14,200 child care centers, however, imply that 470,000 children attend licensed centers that have significant LBP hazards.

Centers where the majority of children are African American are four times as likely (30% compared to 7%) to have significant LBP hazards as those where a majority of the children are white. In housing this difference was smaller, with 29 percent of African American homes having significant LBP hazards and 25 percent of white homes having significant LBP hazards.<sup>3</sup>

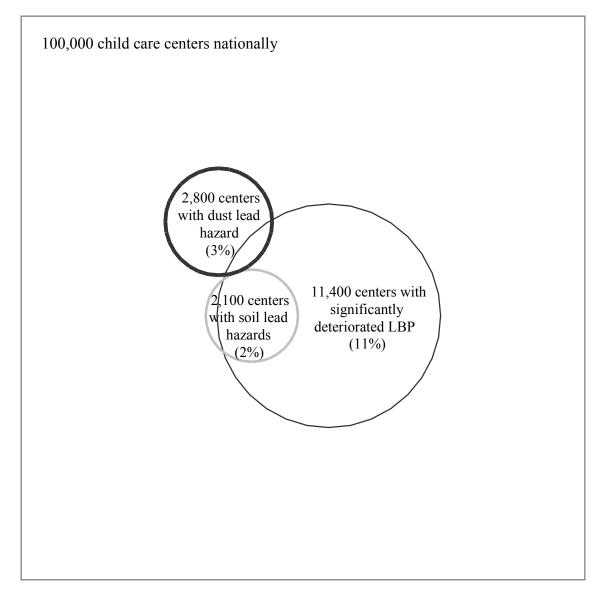
Figure ES-1 presents graphically the number of centers by type of hazard. The predominant type of hazard was deteriorated LBP (11%), not dust lead (3%) or soil lead (2%). Eighty percent of centers with hazards had a paint-lead hazard.

<sup>&</sup>lt;sup>1</sup> The main chapters of the report include 95 percent confidence intervals for all estimates. These have been excluded from the Executive Summary.

<sup>&</sup>lt;sup>2</sup> National Survey of Lead and Allergens in Housing, Volume 1: Analysis of Lead Hazards, Final Report, October 31, 2002, U.S. Department of Housing and Urban Development.

<sup>&</sup>lt;sup>3</sup> In the housing survey, race for a home was defined as the race of the youngest household member.

Figure ES-1. Significant LBP hazards in child care centers by type of hazard



#### **Lead-Based Paint**

An estimated 28,000 or 28 percent of licensed child care centers in the continental United States have LBP on either the interior or exterior painted surfaces, or both. As expected, centers in older buildings are more likely to have LBP than newer ones. An estimated 51 percent of centers in buildings built before 1960 have LBP, while few newer buildings show LBP.

An estimated 15,800 or 16 percent of centers in the United States have *deteriorated* LBP. The deteriorated LBP is only on the exterior for more than half of the centers with deteriorated LBP. An estimated 11,400 or 11 percent of centers in the United States have *significantly deteriorated* LBP. Roughly 60 percent of these centers have significant deterioration only on exterior surfaces. The data suggest that older buildings are more likely to have deteriorated LBP than newer ones. While few newer buildings have deteriorated LBP, 33 percent of child care centers in buildings built before 1960 have it. Twenty-four percent of the older center buildings have significantly deteriorated LBP.

An estimated 11.8 million square feet of painted interior surfaces are covered with LBP. This represents 3 percent of the area of painted interior surfaces in all centers. Conversely, 32 percent of paint on trim contains LBP, but the total surface area of LBP on trim is only 25 percent of the area of LBP on all interior painted surfaces.

An estimated 18.1 million square feet of painted exterior surfaces are covered with LBP. This represents 13 percent of the area of painted exterior surfaces in all centers. Wall siding accounts for most (90%) of the surface area of LBP.

#### **Dust and Soil Lead**

An estimated 3 percent of all licensed child care centers have a dust lead hazard somewhere in the center. An estimated 2 percent of centers have a soil lead hazard, with play area bare soil lead levels above 400 ppm.

Higher bare soil lead concentrations occur for centers with significantly deteriorated exterior LBP. Less than 1 percent of centers free of significantly deteriorated exterior LBP have bare soil lead levels above 400 ppm, while 16 percent of centers with significantly deteriorated exterior LBP have bare soil lead levels above 400 ppm.

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#### **Survey Design and Methodology**

In order to meet the survey objectives, a nationally-representative sample of 334 licensed child care centers was drawn from 30 clusters called *primary sampling units* (PSUs).<sup>4</sup> A general two-stage sample design was utilized to accomplish these goals as efficiently as possible. A total of 168 eligible centers (licensed, with children under 6 years of age, located in the contiguous United States) were recruited into the survey. In each recruited center, samples of dust and soil were collected and painted surfaces were tested for lead using licensed inspectors. Unlicensed day care centers were not included in this survey.

Only classrooms and "multipurpose" rooms (e.g., cafeterias, libraries, ballrooms, and gymnasiums) where children under 6 years of age regularly spent time were included in the study. All classrooms were enumerated on one list, while all such multipurpose rooms were enumerated on another. Up to two classrooms and two multipurpose rooms were then randomly sampled from the lists. A total of 336 rooms were sampled.

Within each room, randomly selected locations on the walls, windows, and other surfaces were tested for lead through dust wiping and x-ray fluorescence (XRF) testing. A composite soil sample was collected at up to two sites on the property of each child care center near children's play areas. Each sample was a composite sample from three locations along the length of the sample site. All samples and questionnaire data were collected between July and October 2001.

<sup>&</sup>lt;sup>4</sup> A PSU is a metropolitan statistical area (MSA), county, or cluster of counties that has a minimum population of 15,000 and does not cross Census region boundaries.

#### 1. INTRODUCTION

The First National Environmental Health Survey of Child Care Centers (referred to here as the CCC Survey) was conducted under the sponsorship of the Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), and the Consumer Product Safety Commission (CPSC) to assess children's potential exposure to lead, allergens, and pesticides in licensed child care centers. Lead levels were estimated in dust, paint, and play area soil; indoor allergen (allergy-inducing substance) levels were measured in dust; and pesticide residues were determined on indoor surfaces and in play area soils. Combining the goals of HUD, EPA, and CPSC into a single survey saved significant public funds, reduced the survey response burden on the public, and substantially reduced the time required to obtain the data needed.

This report, Volume I, includes the findings for lead hazards and describes lead levels in dust, soil, and paint in the Nation's child care centers by age, type, geographical location, and exposed populations. In addition, the report estimates the number and percent of child care centers with dust and soil lead levels above the thresholds in EPA's Lead Hazards Standards Rule (40 CFR 765, January 5, 2001) and HUD's Lead Safe Housing Rule (24 CFR Part 35 et al., *Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance*, effective September 15, 2000).

#### 1.1 Background

Lead is a toxin that affects the central nervous system and is particularly damaging to the developing nervous system of young children and fetuses. High blood lead levels can result in convulsions, mental retardation, and even death. Research has shown that even low lead levels can have serious health consequences. These include reduced intelligence and short-term memory, slower reaction times, poorer hand-eye coordination, reduced height, hearing problems, and numerous behavioral problems.<sup>1</sup>

Although there are many sources of lead in the environment, including drinking water, food, emissions from gasoline combustion, and industrial emissions, it is clear that lead-based paint (LBP) hazards and the contaminated dust and soil they generate cause most childhood lead poisoning today.

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<sup>&</sup>lt;sup>1</sup> National Academy of Sciences (1993). *Measuring lead exposure in infants, children, and other sensitive populations*. National Academy Press, Washington, DC.

Research indicates that dust and soil may be the most significant pathways for lead exposure, and that LBP is the major important source of household dust lead.<sup>2,3,4,5</sup>

HUD is implementing a major effort to eliminate childhood lead paint poisoning. HUD has integrated its program for addressing this health threat into its Healthy Homes Initiative, a program of research, outreach, and demonstration projects to address housing-related problems related to the health of children.

CPSC's mandate is to "protect the public against unreasonable risks of injuries and deaths associated with consumer products." Over the years much of their work has been in child care facilities. According to CPSC there are 21 million children under age 6 in this country, almost 13 million of whom are placed in nonparental child care during some portion of the day. CPSC estimates that there are about 100,000 licensed institutional (i.e., nonhome-based) child care centers in the Nation<sup>6</sup>. About 29 percent of children who receive daycare are in center-based care, including daycare centers, Head Start programs, and nursery schools. Children often spend as many as 10 or 11 hours per day in centers.

Until now, little was known about lead hazards in daycare centers nationwide. This was discussed in the report, *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards*<sup>4</sup>, produced by the President's Task Force on Environmental Health Risks and Safety Risks to Children. HUD and CPSC agreed to cooperate on addressing this gap. In furtherance of these activities, HUD and CPSC are now working collaboratively to understand the extent and condition of LBP on interior and exterior components, LBP on play equipment, lead in interior dust, and lead in soil in licensed daycare centers nationwide.

The CCC Survey followed, and in some ways built on the National Survey of Lead and Allergens in Housing<sup>7</sup> (NSLAH). This path-breaking survey determined lead and allergen levels in a

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<sup>&</sup>lt;sup>2</sup> Bornschein, R., Hammond, P.B., Dietrich, et al. (1985a). The Cincinnati prospective study of low-level lead exposure and its effects on child development: Protocol and status report. *Environ. Res.* 38:4-18.

<sup>&</sup>lt;sup>3</sup> Bornschein, R., Succop, P., Dietrich, et al. (1985b). The influence of social and environmental factors on dust lead, hand lead, and blood lead levels in young children. *Environ. Res.* 38:108-118.

<sup>&</sup>lt;sup>4</sup> President's Task Force on Environmental Health Risks and Safety Risks to Children, ICF Consulting Associates. (2000). *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards*, Washington DC.

<sup>&</sup>lt;sup>5</sup> Lanphear, B.P., Matte, T.D., Rogers, J., Clickner, R.P., Dietz, B., et al. (1998). The contribution of lead-contaminated house dust and residential soil to children's blood lead levels: A pooled analysis of 12 epidemiologic studies. *Environmental Research, Section A*, 79, 51-68.

<sup>&</sup>lt;sup>6</sup> CPSC web site (http://www.cpsc.gov/).

<sup>&</sup>lt;sup>7</sup> National Survey of Lead and Allergens in Housing, Volume I: Analysis of Lead Hazards, Final Report, October 31, 2002, U.S. Department of Housing and Urban Development.

large nationally representative sample of homes, using dust wipes, x-ray fluorescence (XRF) analyzers, soil collection, and dust vacuuming. All of these methods were retained by the CCC Survey, as were many of the staff, procedures, and forms used by that earlier study. The CCC Survey focused on licensed child care centers, rather than the broader range of child care facilities in homes and centers because the NSLAH had already produced lead and allergen level estimates for homes. It is assumed that child care provider homes are systematically different from other homes. The two national surveys in homes and child care centers supplement with each other and provide prevalence estimates of lead hazards in two major exposure environments for young children.

#### 1.2 Survey Objectives

One of the Federal Government's principal objectives for the CCC Survey was to develop a scientific description of the existing lead levels in dust, soil, and paint in the Nation's child care centers. In addition, the survey of lead hazards in centers collected data to do the following:

- Estimate the number and percent of centers with dust and soil lead levels above selected thresholds;
- Identify likely sources of lead in dust in centers, e.g., paint and soil;
- Permit future analyses of lead hazard control strategies and costs (e.g., quantities of deteriorated painted surfaces); and
- Permit future analyses for regulation, policy, and guidance that protect children and also minimize regulatory and program implementation burden.

In order to meet these survey objectives, a nationally-representative sample of 334 child care centers was drawn from 30 geographic clusters called *primary sampling units* (PSUs).<sup>8</sup> A general two-stage sample design was utilized to accomplish these goals as efficiently as possible. No national list of licensed child care centers exists. For each of the 30 sampled PSUs, a list was compiled by contacting the licensing organization in each state. The sample of 334 child care centers was selected from this list. A total of 168 eligible centers were recruited into the survey. In each recruited center, samples of dust and soil were collected and painted surfaces were tested. (See Volume III: *Design and Methodology* for details on design and data collection protocols.)

<sup>&</sup>lt;sup>8</sup> A PSU is a metropolitan statistical area (MSA), county, or cluster of counties that has a minimum population of 15,000 and does not cross Census region boundaries.

#### 1.3 Report Organization

The report for the CCC Survey consists of four volumes: Volume I presents the major lead hazard findings, Volume II presents the major allergen findings, Volume III presents the survey design and methodology, and Volume IV provides documentation for the survey data files.

There are seven chapters in Volume I, including this introduction. Descriptions of each chapter are as follows:

- Chapter 2 describes the population surveyed, both centers and children enrolled in the centers.
- Chapter 3 presents the estimates of the prevalence of significant lead hazards in centers based on the findings presented in Chapters 4, 5, and 6 for paint, dust, and soil, respectively. The types of hazard (paint, dust, and soil) are also presented.
- Chapter 4 presents the estimates of the prevalence and amount of LBP and deteriorated LBP in centers, including paint lead loadings.<sup>9</sup>
- Chapter 5 presents the estimates of the prevalence of lead-contaminated dust in centers, including the dust lead loadings and the association between interior dust lead and interior LBP condition.
- Chapter 6 presents the estimates of the prevalence of lead-contaminated soil in centers, including soil lead concentrations and the association between soil lead and exterior LBP condition.
- Chapter 7 examines the quality of the data and the resulting quality of projected national estimates. In order to do this, the chapter addresses nonresponse rates and classification bias due to measurement error. A summary of field data collection quality control activities is also provided.

In the subsequent chapters, the precision of the results (shown in parentheses) is reported using 95 percent confidence intervals. The primary survey results are compared to similar results for homes from the NSLAH. <sup>10</sup>

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<sup>&</sup>lt;sup>9</sup> Throughout the volume, the concepts of lead loading and lead concentration are used. Lead in paint and dust is reported as loading, while lead in soil is reported as a concentration. For paint, lead loading is the number of milligrams of lead per square centimeter of painted surface (mg/cm²). For dust, lead loading is the number of micrograms of lead per square foot of wiped surface (μg/ft²). Soil is reported as the number of micrograms of lead per gram of soil (μg/g), equivalent to parts per million (ppm).

<sup>&</sup>lt;sup>10</sup> National Survey of Lead and Allergens in Housing, Volume I: Analysis of Lead Hazards, Final Report, October 31, 2002, U.S. Department of Housing and Urban Development.

#### 2. SURVEYED CHILD CARE CENTER POPULATION

The First National Environmental Health Survey of Child Care Centers (referred to here as the CCC Survey) population included all licensed child care centers that serve children under age 6 in the 48 contiguous United States. The surveyed centers were located in buildings in all age categories. Centers built in 1978 or after were included to determine whether centers in newer buildings have fewer lead hazards. Unlicensed child care centers were excluded because it was not possible to get a list from which to sample. The eligible national population of child care centers consisted of approximately 100,000 licensed centers.

A nationally-representative sample of 334 centers was drawn from 30 clusters called primary sampling units (PSUs).<sup>2</sup> The 30 PSUs were randomly selected from 1,389 PSUs across the continental United States. Of the 334 sampled centers, 68 were not eligible for the survey. Of the remaining 266 eligible centers, a total of 168 eligible centers were recruited and completed the survey, for a completion rate of 70.7 percent.

The sample was to be restricted to licensed child care centers in the 48 contiguous United States and District of Columbia. While it would be of interest to collect information from all forms of child care facilities, no lists of non-licensed centers existed from which to select a sample. To survey non-licensed, home-based centers would require a national sample of homes, whose occupants would then be asked if they provide child care from their homes. It would be possible to include licensed home-based child care, but information on lead and allergens in homes with children can be obtained from the recently completed National Survey of Lead and Allergens in Housing. This provides some insight into the situation in both licensed and non-licensed home-based child care. Thus it was decided to focus the current survey on larger, generally not home-based child care centers.

Table 2-1 presents the national estimates for selected characteristics of the survey population, including year of construction, geographic region, degree of urbanization, majority race, percent of children receiving government subsidies, percent of operating costs from government subsidies, whether a Head Start center, center ownership (private or government), and whether centers or

<sup>&</sup>lt;sup>1</sup> LBP was banned for residential use in 1978. Because it was not banned for commercial use, it was unknown whether LBP would be present in newer buildings occupied by child care centers.

<sup>&</sup>lt;sup>2</sup> See Volume III for description of PSUs.

children have been tested for lead.<sup>3</sup> All estimates presented are weighted national estimates as discussed in Volume III. Chapter 7 of this volume discusses the potential effect of nonresponse bias.

Based on the survey data there are an estimated 100,000 licensed child care centers (87,600 to 112,300)<sup>4,5</sup> serving children under 6 in the continental United States. Of these, 34 percent (28% to 41%) were located in buildings built since 1978, 23 percent (17% to 30%) were built between 1960 and 1977, and 29 percent (25% to 34%) before 1960. The remaining 14 percent did not provide a building age.<sup>6</sup> Forty percent of centers in the Northeast and Midwest (31% to 49%) were located in pre-1960 buildings compared to 21 percent (16% to 26%) in the South and West.

About half the centers are located in central cities. In half of the centers most children are described as white, while in the other half most children are black, Hispanic, or another minority. Over half the centers received government subsides to support at least some of their operating costs, while over 70 percent of centers have some children receiving government subsidies. Nine percent of centers (5% to 17%) have Head Start programs and 79 percent (69% to 86%) are privately owned. Most centers have never been tested for lead and do not require blood lead tests for children before enrollment.

Table 2-2 presents the national estimates for number of children in centers with selected center characteristics. Based on the survey results, there are an estimated 4.62 million children (3.70 to 5.55 million) under age 6 enrolled in licensed child care centers. The percent of children enrolled by characteristics of their child care center is similar to the percent of centers by the same characteristics (comparing Table 2-1 and Table 2-2).

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<sup>&</sup>lt;sup>3</sup> Cross comparisons of two variables (e.g., region by construction year) result in cells containing 30 or fewer centers. Caution is recommended in the interpretation of results from these and other sparse cells.

<sup>&</sup>lt;sup>4</sup> 95% confidence intervals for estimates from the survey are shown in parentheses.

<sup>&</sup>lt;sup>5</sup> Throughout the report tables, the number of centers has been rounded to hundreds of centers, the number of children has been rounded to units of 10,000 children, and percentages have been rounded to integral percents. Due to rounding, the numbers in the tables may not add up to the totals for all centers. Even with the rounding, the precision of the numbers (as represented by the confidence intervals) may not justify all digits displayed.

<sup>&</sup>lt;sup>6</sup> In the interpretation of the data by year of construction, it is important to keep the source of the data in mind. Center directors were asked the year their building was constructed. If a director could not report the exact year, he or she was asked to report the construction year in ranges: 1978-2001, 1960-1977, before 1960 or unknown. Many center directors did not know the age of the building. The ages of some buildings were verified from housing or taxing authorities. (See Volume III for details.)

Table 2-1. National survey estimates of child care centers

	N	rs	Centers in		
Child Care Center Characteristics	Estimate	Estimate (%)	Lower 95% CI (%)	Upper 95% CI (%)	Sample
All Centers	100,000	100	(, ,)	- (, , ,	168
<b>Construction Year</b>					
1978 to 2001	33,800	34	28	41	57
1960 to 1977	22,900	23	17	30	45
Before 1960	29,200	29	25	34	53
Unknown	14,100	14			13
Region	,				
Northeast/Midwest	45,200	45	39	52	79
South/West	54,800	55	48	61	89
<b>Region by Construction Year</b>	- ,				
Northeast/Midwest					
1978 to 2001	12,100	27	19	37	23
1960 to 1977	9,700	22	14	31	19
Before 1960	17,900	40	31	49	31
Unknown	5,400	12		.,	6
South/West	,,,,,,				
1978 to 2001	21,600	40	30	49	34
1960 to 1977	13,200	24	16	34	26
Before 1960	11,300	21	16	26	22
Unknown	8,700	16	10	20	7
Urbanization	- ,				
MSA Central City	51,200	51	36	66	83
Other MSA	26,600	27	16	40	42
Rural	22,200	22	10	43	43
Majority Race at the Center					
White	51,300	51	41	62	96
African American	26,800	27	17	40	37
Other	19,200	19	11	30	31
Refusal/Don't Know	2,700	3			4
<b>Percent of Children at the Center</b>					
Getting Govt. Subsidy					
Greater than 50%	28,900	29	20	39	44
1% to 50%	39,200	39	31	48	73
None	25,800	26	18	36	41
Refusal/Don't Know	6,000	6			10
<b>Percent of Operating Costs from</b>					
Govt. Subsidy					
Greater than 50%	22,200	22	15	31	36
1% to 50%	26,700	27	20	35	47
None	35,000	35	27	43	62
Refusal/Don't Know	16,000	16			23

Table 2-1. National survey estimates of child care centers (continued)

	N	umber and Pe	ercent of Center	rs	Centers in	
Child Care Center Characteristics	Estimate	Estimate (%)	Lower 95% CI (%)	Upper 95% CI (%)	Sample	
Center Has Headstart Program						
Yes	9,000	9	5	17	14	
No	89,400	89	83	94	152	
Refusal/Don't Know	1,500	2			2	
Center Ownership						
Private	78,900	79	69	86	134	
Government	19,200	19	12	29	31	
Refusal/Don't Know	1,800	2			3	
Center Ever Tested for Lead						
Yes	19,500	19	14	27	34	
No	65,800	66	57	73	111	
Refusal/Don't Know	14,600	15			23	
Children Required to Have Blood						
Test for Lead						
Yes	19,400	19	11	32	31	
No	73,800	74	60	84	127	
Refusal/Don't Know	6,800	7			10	

CI = Confidence limit for a 95% confidence interval for the estimated percent

MSA = Metropolitan Statistical Area, the "MSA Central City" includes the county in which the MSA central city is located Percentages (other than region by construction year) use 99,952 centers as the denominator

Values may not add up to the total due to rounding

Table 2-2. National survey estimates of children under age 6 in child care centers

	Numb	Number and Percent of Children Under 6							
Child Care Center Characteristics	Estimate	Estimate (%)	Lower 95% CI (%)	Upper 95% CI (%)	Centers in Sample				
All Centers	4,620,000	100	,	· · · · · · · · · · · · · · · · · · ·	168				
<b>Construction Year</b>									
1978 to 2001	1,540,000	33	25	42	57				
1960 to 1977	820,000	18	12	25	45				
Before 1960	1,270,000	27	19	38	53				
Unknown	990,000	22			13				
Region									
Northeast/Midwest	2,210,000	48	37	58	79				
South/West	2,410,000	52	42	63	89				
<b>Region by Construction Year</b>									
Northeast/Midwest									
1978 to 2001	420,000	19	10	33	23				
1960 to 1977	340,000	16	8	30	19				
Before 1960	870,000	39	21	61	31				
Unknown	570,000	26			6				
South/West									
1978 to 2001	1,110,000	46	35	58	34				
1960 to 1977	480,000	20	12	30	26				
Before 1960	400,000	17	11	24	22				
Unknown	420,000	17			7				
Urbanization	<u> </u>								
MSA Central City	2,610,000	56	37	74	83				
Other MSA	1,120,000	24	12	44	42				
Rural	890,000	19	8	40	43				
<b>Majority Race at Center</b>									
White	2,360,000	51	37	65	96				
African American	850,000	18	10	30	37				
Other	1,300,000	28	16	45	31				
Refusal/Don't Know	110,000	2			4				
Percent of Children Getting Govt.									
Subsidy									
Greater than 50%	1,610,000	35	20	53	44				
1% to 50%	1,680,000	36	26	48	73				
None	1,130,000	24	14	40	41				
Refusal/Don't Know	210,000	5			10				
<b>Percent of Operating Costs from</b>	1								
Govt. Subsidy	1								
Greater than 50%	1,340,000	29	15	48	36				
1% to 50%	1,000,000	22	14	32	47				
None	1,580,000	34	23	48	62				
Refusal/Don't Know	690,000	15			23				

Table 2-2. National survey estimates of children under age 6 in child care centers (continued)

	Numbe	Number and Percent of Children Under 6						
Child Care Center Characteristics	Estimate	Estimate (%)	Lower 95% CI (%)	Upper 95% CI (%)	Centers in Sample			
Center Has Headstart Program								
Yes	410,000	9	4	17	14			
No	4,120,000	89	81	94	152			
Refusal/Don't Know	90,000	2			2			
Center Ownership					_			
Private	3,750,000	81	69	89	134			
Government	780,000	17	10	27	31			
Refusal/Don't Know	90,000	2			3			
<b>Center Ever Tested for Lead</b>								
Yes	740,000	16	10	25	34			
No	3,180,000	69	59	78	111			
Refusal/Don't Know	700,000	15			23			
Children Required to Have Blood								
Test for Lead								
Yes	830,000	18	9	32	31			
No	3,620,000	78	66	87	127			
Refusal/Don't Know	180,000	4			10			

CI = Confidence limit for a 95% confidence interval for the estimated percent

Values may not add up to the total due to rounding

MSA = Metropolitan Statistical Area, the "MSA Central City" includes the county in which the MSA central city is located Percentages (other than region by construction year) use 4,624,751 children as the denominator

#### 3. LEAD-BASED PAINT HAZARDS IN CHILD CARE CENTERS

Chapter 3 presents the estimates of the prevalence of lead-based paint (LBP) hazards in licensed child care centers, based on the findings presented in Chapters 4, 5, and 6. The types of hazard (paint, dust, and soil) are also presented.

#### 3.1 Definition of Lead-Based Paint Hazards

The number of child care centers classified as having a LBP hazard depends on the definition employed in such classification. Under Title X, a LBP hazard is defined as "any condition that causes exposure to lead from lead-contaminated dust; bare, lead-contaminated soil; LBP that is deteriorated; or LBP present on accessible surfaces, friction surfaces, or impact surfaces" in a child occupied facility. Several operational definitions have been developed since Title X was enacted. They involve varying thresholds for lead-contaminated dust and soil and deteriorated LBP. This report focuses on *significant LBP hazards*, defined in accordance with the HUD Lead Safe Housing Rule (24 CFR 35). If any of the following situations exist in a home or child-occupied facility, then a significant LBP hazard exists under this definition:

- Deteriorated LBP LBP with deterioration larger than the *de minimis* levels per Section 35.1350(d) of the EPA and HUD Lead Safe Housing rule, viz., deterioration of more than 20 square feet (exterior) or 2 square feet (interior) of LBP on large surface area components (walls, doors) or damage to more than 10 percent of the total surface area of interior small surface area components types (window sills, baseboards, trim). LBP is defined as any paint or other surface coating (e.g., varnish, lacquer, or wallpaper over paint) that contains lead equal to or greater than 1.0 mg/cm<sup>2</sup>; or
- Lead-Contaminated Dust Dust on floors with greater than or equal to 40 μg/ft² lead, dust on window sills with greater than or equal to 250 μg/ft² lead as measured by wipe sampling; or
- Bare, Lead-Contaminated Soil Lead content of 400 ppm or more for any amount of bare soil in a play area frequented by a child under the age of 6 years.

The findings in the body of this report are based on this definition of a significant LBP hazard.

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<sup>&</sup>lt;sup>1</sup> Intact LBP present on accessible surfaces, friction surfaces, or impact surfaces were not included in the definition of LBP hazard for the estimates presented in this report because this information was not specifically collected for each component.

#### 3.2 Prevalence of Significant Lead-Based Paint Hazards in Centers

An estimated 14,200 (7,200 to 21,300)<sup>2</sup> or 14 percent (9% to 22%) of licensed child care centers in the continental United States have significant LBP hazards. Table 3-1 presents the number and percentage of centers with significant LBP hazards by selected characteristics, including center building age, region of the country, degree of urbanization, majority race, percent of children receiving a government subsidy, percent of operating cost from government subsidies, whether it is a Head Start program, ownership, and whether the center or children are tested for lead.

Centers in older buildings are more likely to have significant LBP hazards then those in newer buildings. An estimated 26 percent (15% to 42%) of centers built before 1960 have significant LBP hazards, compared to around 4 percent of centers in newer buildings. Centers where the majority of children are African American are four times as likely (30% compared to 7%) to have significant LBP hazards as those where a majority of the children are white.

Another finding, not shown in Table 3-1, is that an estimated 470,000 children under age 6 (170,000 to 760,000) attend licensed child care centers that have significant LBP hazards. This represents 10 percent (4% to 17%) of all children under age 6 who attend licensed child care centers.

<sup>&</sup>lt;sup>2</sup> 95% confidence intervals are shown in parentheses.

Table 3-1. Prevalence of child care centers with significant LBP hazards, by selected characteristics

Child Care Center	Number of	Number o	f Centers with t LBP Hazards	Significant	Signi	Centers in		
Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Total Centers	100,000	14,200	7,200	21,300	14	9	22	168
<b>Construction Year</b>								
1978 to 2001	33,800	1,500	500	4,400	4	1	13	57
1960 to 1977	22,900	1,300	400	3,900	5	2	17	45
Before 1960	29,200	7,700	3,100	12,300	26	15	42	53
Unknown	14,100	3,900			27			13
Region								
Northeast/Midwest	45,200	8,500	3,000	14,100	19	10	32	79
South/West	54,800	5,700	1,100	10,300	10	5	22	89
Region by Construction Year		,						
Northeast/Midwest								
1978 to 2001	12,100	600	100	3,200	5	1	26	23
1960 to 1977	9,700	0	0	2,400	0	0	25	19
Before 1960	17,900	6,600	2,300	11,000	37	20	58	31
Unknown	5,400	1,300	2,500	11,000	24	20	30	6
South/West	3,100	1,500						
1978 to 2001	21,600	900	200	3,300	4	1	15	34
1960 to 1977	13,200	1,300	400	3,700	10	3	28	26
Before 1960	11,300	1,000	200	3,500	9	2	31	22
Unknown	8,700	2,600	200	3,300	29	2	31	7
Urbanization	8,700	2,000			29			,
MSA Central City	51,200	9,000	2,600	15,400	18	9	31	83
Other MSA			500			2		42
Rural	26,600 22,200	2,000 3,200	500	7,200 5,900	8 14	10	27 21	42
Majority Race	22,200	3,200	300	3,900	14	10	21	43
White	51 200	2 400	500	6 200	_	2	1.4	06
African American	51,300	3,400		6,200 14,700	7 30	3 15	14 50	96 37
Other	26,800	8,000	1,200 400		11	2	43	31
	19,200	2,100	400	8,200		2	43	
Refusal/Don't Know	2,700	800			28			4
Percent of Children Getting Govt. Subsidy								
Greater than 50%	20,000	7.000	1 (00	12 400	24	12	40	4.4
	28,900	7,000	1,600	12,400	24	13	40	44
1% - 50%	39,200	3,700	1,200	10,000	9	3	25	73
None	25,800	1,200	400	3,500	5	1	14	41
Refusal/Don't Know	6,000	2,300			38			10
Percent of Operating Costs from								
Govt. Subsidy	22.200	2 200	1 000	0.100	1.4	_	27	26
Greater than 50%	22,200	3,200	1,000	8,100	14	5	37	36
1% - 50%	26,700	4,100	400	7,900	15	6	34	47
None	35,000	2,500	700	4,400	7	3	14	62
Refusal/Don't Know	16,000	4,400			28			23
Headstart Program	0.00	2 000						
Yes	9,000	2,800	600	6,800	31	6	76	14
No	89,400	9,900	3,800	16,100	11	6	19	152
Refusal/Don't Know	1,500	1,500			100			2
Center Ownership								
Private	78,900	10,600	4,100	17,100	13	7	23	134
Government	19,200	1,800	400	6,800	9	2	35	31
Refusal/Don't Know	1,800	1,800			100			3

Table 3-1. Prevalence of child care centers with significant LBP hazards, by selected characteristics (continued)

Child Care Center	Number of		f Centers with LBP Hazards	Significant		Percent with ficant LBP H	_	Centers in
Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Center Ever Tested for Lead								
Yes	19,500	2,800	110,500	625,800	14	6	32	34
No	65,800	6,800	1,400	12,300	10	5	21	111
Refusal/Don't Know	14,600	4,600			31			23
Children Required to Have Blood								
Test for Lead								
Yes	19,400	4,900	200	9,700	26	12	47	31
No	73,800	6,500	2,100	10,900	9	5	16	127
Refusal/Don't Know	6,800	2,800			41			10

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

MSA = Metropolitan Statistical Area, the "MSA Central City" includes the county in which the MSA central city is located Percentages use the number of centers in that row as the denominator

Table 3-2 presents the number of centers with significant LBP hazards by location in the building--either interior or exterior, or both. For half the centers with significant LBP hazards, it is only present on the exterior.

Table 3-2. Prevalence of significant LBP hazards by location in the child care center

Presence and	N	umber of Center	Percen	Centers in			
Location of Significant LBP Hazard	Estimate	Lower 95% CI	Upper 95% CI	Percent	Lower 95% CI	Upper 95% CI	Sample
Present Interior Only	3,100	400	5,900	3	1	7	7
Present Both Interior and							
Exterior	4,200	118,000	1,370,200	4	1	14	4
Present Exterior Only	7,000	1,800	12,100	7	3	14	10
Subtotal - Present Anywhere in Center	14,200	7,200	21,300	14	9	22	21
No Significant LBP Hazard	85,700	73,700	97,700	86	78	91	147
All Centers	100,000	87,600	112,300	100			168

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

Table 3-3 presents data for the presence of significant LBP hazards in centers by type of hazard. Figure 3-1 graphically displays the same information. Eighty percent (11,400 out of 14,200) of the centers with a significant lead hazard have paint-related hazards.

Table 3-3. Prevalence of significant LBP hazards in child care centers by type of hazard

	Nun	nber of Cen	ters	Perce	Contors in		
Type of Hazard	Estimate	Lower 95% CI	Upper 95% CI	Percent	Lower 95% CI	Upper 95% CI	Centers in Sample
Paint	11,400	4,100	18,700	11	6	20	15
Dust	2,800	300	5,400	3	1	7	6
Soil	2,100	700	6,400	2	1	6	3
Any Hazard	14,200	7,200	21,300	14	9	22	21

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

100,000 child care centers nationally 2,800 centers with dust lead hazard  $(3\%)_{/}$ 11,400 centers with 2,100 centers significantly with soil lead deteriorated LBP hazards (11%)(2%)

Figure 3-1. Significant LBP hazards in child care centers by type of hazard

# 3.3 Comparison of Significant Lead-Based Paint Hazards Between Child Care Centers and Homes

Table 3-4 shows comparable estimates of the prevalence of significant LBP hazards between child care centers and homes (based on the National Survey of Lead and Allergens in Housing). Age, region, race and urbanization categories were combined to calculate comparable estimates between the two surveys. In general, almost twice the percent of homes have significant LBP hazards as child care

centers. The trends by construction year category and region are similar. One noticeable exception is for buildings built since 1978. LBP was outlawed for homes beginning in 1977, but not so for commercial buildings. Incidence levels for child care centers in rural and MSA areas are similar, unlike for homes. A greater percentage of child care centers in which most children are African American appear to have significant LBP hazards than centers in which most children are from other race/ethnicity groups. This pattern is not seen in the housing survey data.

Table 3-4. Comparison of the prevalence of significant LBP hazards between child care centers and homes, by type of building characteristic

Child Care Center/Home	Percent(%) with Significant LBP Hazards							
Characteristics	Chil	d Care Cer	nters		Homes			
	Estimate	Lower	Upper	Estimate	Lower	Upper		
	Listillate	95% CI	95% CI	Listillate	95% CI	95% CI		
All Centers or Homes	14	9	22	25	22	28		
<b>Construction Year</b>								
1978 to 2001	4	1	13	3	1	6		
1960 to 1977	5	2	17	8	5	12		
Before 1960	26	15	42	54	48	61		
Unknown	27			0				
Region								
Northeast/Midwest	19	10	32	36	31	41		
South/West	10	5	22	17	14	20		
Urbanization								
MSA	14	6	22	23	20	27		
Rural	14	10	21	30	20	40		
Majority Race								
White	7	3	14	25	22	28		
African American	30	15	50	29	20	38		
Other	11	2	43	23	11	34		
Refusal/Don't Know	28			27				

#### 4. LEAD-BASED PAINT IN CHILD CARE CENTERS

Chapter 4 presents estimates of the prevalence, location, and amount of lead-based paint (LBP) and deteriorated LBP in licensed child care centers. LBP is defined as any paint or other surface coating (e.g., varnish, lacquer, or wallpaper over paint) that contains lead equal to or greater than 1.0 mg/cm². The estimates for deteriorated LBP and significantly deteriorated LBP are presented in Section 4.2. LBP is considered to be deteriorated as long as there is any deterioration. It is considered to be significantly deteriorated if the deterioration exceeds the *de minimis* thresholds given in the definition of a significant LBP hazard presented in Chapter 3.

#### 4.1 Prevalence of Lead-Based Paint

An estimated 28,000 (20,100 to 35,900) or 28 percent (22% to 35%) of licensed child care centers in the continental United States have LBP on either the interior or exterior painted surfaces, or both. Table 4-1 presents the number and percentage of centers with LBP by selected characteristics, including year of construction, geographic region, degree of urbanization, majority race, percent of children receiving a government subsidy, percent of operating cost from government subsidies, whether it is a Head Start program, ownership, and whether the center or children are required to be tested for lead.

As expected, centers in older buildings are more likely to have LBP than newer ones. An estimated 51 percent (38% to 63%) of centers in buildings built before 1960 have LBP, while only 22 percent (14% to 34%) of buildings built between 1960 and 1977 and 7 percent (3% to 16%) of post-1978 buildings show LBP. The differences among LBP prevalence by region, urbanization, majority race, and the other table variables do not appear to be significant in that the confidence intervals overlap.

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<sup>&</sup>lt;sup>1</sup> 95% confidence intervals are shown in parentheses.

Table 4-1. Prevalence of LBP by selected child care center characteristics

Child Care Center	Number of	Number	of Centers wit	h LBP	P	ercent with	LBP	Centers in
Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Total Centers	100,000	28,000	20,100	35,900	28	22	35	168
Construction Year								
1978 to 2001	33,800	2,500	200	4,700	7	3	16	57
1960 to 1977	22,900	5,000	2,200	7,900	22	14	34	45
Before 1960	29,200	14,900	9,600	20,100	51	38	63	53
Unknown	14,100	5,600	>,000	20,100	40	20	03	13
Region	11,100	2,000						- 15
Northeast/Midwest	45,200	14,900	8,900	20,800	33	24	43	79
South/West	54,800	13,100	7,400	18,800	24	16	34	89
Region by Construction Year	2 1,000	13,100	7,.00	10,000			<u> </u>	0,
Northeast/Midwest								
1978 to 2001	12,100	1,200	36,500	341,000	10	3	28	23
1960 to 1977	9,700	2,200	50,500	3,900	22	12	37	19
Before 1960	17,900	9,300	5,200	13,400	52	36	67	31
Unknown	5,400	2,200	3,200	13,400	41	30	07	6
South/West	3,400	2,200			41			0
1978 to 2001	21 600	1 200	29 500	275 200	6	2	17	24
1978 to 2001 1960 to 1977	21,600	1,300	38,500	375,300	6	2	17	34
	13,200	2,900	600	5,200	22	10	40	26
Before 1960 Unknown	11,300	5,600	2,300	8,800	49	30	69	22
	8,700	3,400			39			7
Urbanization	51.200	16,000	0.600	22.500	2.1	22	41	0.2
MSA Central City	51,200	16,000	8,600	23,500	31	23	41	83
Other MSA	26,600	8,000	1,600	14,400	30	15	52	42
Rural	22,200	4,000	600	7,300	18	10	29	43
Majority Race	51.200	10.500	4.000	16100	20		22	0.0
White	51,300	10,500	4,800	16,100	20	12	32	96
African American	26,800	10,700	3,900	17,500	40	24	59	37
Other	19,200	5,600	209,000	1,113,300	29	11	58	31
Refusal/Don't Know	2,700	1,200			45			4
Percent of Children Getting Govt.								
Subsidy								
Greater than 50%	28,900	8,800	3,200	14,400	31	20	44	44
1% - 50%	39,200	9,700	4,000	15,400	25	14	40	73
None	25,800	5,100	2,200	7,900	20	11	32	41
Refusal/Don't Know	6,000	4,400			73			10
Percent of Operating Costs from								
Govt. Subsidy								
Greater than 50%	22,200	5,500	1,400	9,600	25	12	44	36
1% - 50%	26,700	7,900	3,700	12,100	29	18	44	47
None	35,000	7,100	3,300	10,900	20	13	31	62
Refusal/Don't Know	16,000	7,500			47			23
Headstart Program								
Yes	9,000	3,800	103,300	725,500	42	11	81	14
No	89,400	23,400	16,400	30,400	26	20	33	152
Refusal/Don't Know	1,500	800			50			2
Center Ownership								
Private	78,900	23,400	16,600	30,200	30	24	36	134
Government	19,200	3,800	100	7,500	20	7	46	31
Refusal/Don't Know	1,800	800			42			3

Table 4-1. Prevalence of LBP by selected child care center characteristics (continued)

Child Care Center	Number of	Number	of Centers wit	h LBP	P	ercent with	LBP	Centers in
Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Center Ever Tested for Lead								
Yes	19,500	8,500	3,500	13,500	44	25	64	34
No	65,800	13,400	6,100	20,700	20	12	32	111
Refusal/Don't Know	14,600	6,100			42			23
Children Required to Have Blood								
Test for Lead								
Yes	19,400	6,600	2,000	11,200	34	18	54	31
No	73,800	17,200	10,100	24,400	23	17	32	127
Refusal/Don't Know	6,800	4,200			61			10

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

MSA = Metropolitan Statistical Area, the "MSA Central City" includes the county in which the MSA central city is located Percentages use number of centers in that row as the denominator

Table 4-2 presents the number of centers with LBP by location in the building — either interior or exterior, or both. Almost one-half of centers with LBP have it on both interior and exterior surfaces (12% of all centers, or 44% (12/28) of centers with LBP anywhere in the building).

Table 4-2. Prevalence of LBP by location in the child care center

Presence and	Nι	ımber of Cen	ters	Perc	ent of Centers	s (%)	
Location of LBP	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Centers in Sample
Present Interior Only	8,200	3,700	12,800	8	5	14	16
Present Both Interior and Exterior	12,300	5,600	19,000	12	7	20	15
Present Exterior Only	7,500	2,800	12,200	7	4	13	13
Subtotal - Present Anywhere in Center	28,000	20,100	35,900	28	22	35	44
No LBP in Center	72,000	61,600	82,300	72	65	78	124
All Centers	100,000			100			168

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

#### 4.2 Prevalence of Deteriorated Lead-Based Paint

Although 28 percent of centers have LBP, the condition of the paint is important in determining whether a hazard exists. Except during renovations, maintenance, or other activities that could disturb it, intact LBP is believed to pose little immediate risk to occupants. However, significantly deteriorated LBP may present an immediate danger to occupants, especially to young children. Table 4-3 presents the number and percentage of child care centers with any deteriorated LBP and significantly deteriorated (more than the *de minimis* amounts) LBP by location in the building--either interior or exterior, or both.

Table 4-3. Prevalence of deteriorated and significantly deteriorated LBP by location in the child care center

	a. I	Deteriorated LI	3P				
Presence and Location of Deteriorated	Nun	Perce	Centers in				
Lead-Based Paint (LBP)	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Present Interior Only	2,400	900	6,300	2	1	6	5
Present Both Interior and Exterior	4,700	0	9,400	5	2	12	5
Present Exterior Only	8,700	2,900	14,500	9	5	16	13
Subtotal - Present Anywhere in Center	15,800	8,000	23,500	16	10	24	23
No Deteriorated LBP	84,200	72,300	96,100	84	76	90	145
All Centers	100,000			100	•		168
	b. Signific	antly Deterior	ated LBP		•		

Presence and Location of Significantly	Nun	Number of Centers				Percent of Centers (%)			
Deteriorated Lead-Based Paint (LBP)	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample		
Present Interior Only	1,400	400	5,500	1	0	5	3		
Present Both Interior and Exterior	3,400	1,100	10,300	3	1	10	3		
Present Exterior Only	6,600	1,400	11,900	7	3	14	9		
Subtotal - Present Anywhere in Center	11,400	4,100	18,700	11	6	20	15		
No Significantly Deteriorated LBP	88,500	76,500	100,600	89	80	94	153		
All Centers	100,000			100	•	•	168		

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

An estimated 15,800 (8,000 to 23,500) or 16 percent (10% to 24%) of child care centers in the United States have some deteriorated LBP. The deteriorated LBP is on the exterior for over half of

the centers with deteriorated LBP. An estimated 11,400 (4,100 to 18,700) or 11 percent (6% to 20%) of centers in the United States have *significantly* deteriorated LBP. Roughly 60 percent of these centers have significant deterioration on exterior surfaces only.

Table 4-4 presents the number and percentage of centers with deteriorated and significantly deteriorated LBP by construction year. The data suggest that older buildings are more likely to have deteriorated LBP than newer ones. One percent of post-1978 buildings have deteriorated LBP and four percent of centers build between 1960 and 1977 have deteriorated LBP. In contrast, 33 percent (20% to 48%) of centers built before 1960 have it. Of centers built before 1960, 24 percent (13% to 40%) have significantly deteriorated LBP.

Table 4-4. Distribution of centers with deteriorated and significantly deteriorated LBP by construction year

			a. Deteriora	ated LBP				
		Number of C	enters with I	Deteriorated	I	Percent with	1	
Construction Year	Number of		LBP		Deter	iorated LB	P (%)	Centers in
Construction Tear	Centers	Estimate	Lower	Upper	Estimate	Lower	Upper	Sample
		Estillate	95% CI	95% CI	Estimate	95% CI	95% CI	
1978 to 2001	33,800	400	100	2,600	1	0	8	57
1960 to 1977	22,900	1,000	200	3,500	4	1	15	45
Before 1960	29,200	9,600	4,500	14,700	33	20	48	53
Unknown	14,100	4,800			34			13
Total Centers	100,000	15,800	8,000	23,500	16	10	24	168
		b. Significa	ntly Deterior	rated LBP				
		Number of C	enters with S	Significantly	Percent			
	Number of	]	Deteriorated		Deter	Centers in		
Construction Year	Centers		LBP		Deter	Sample		
	Centers	Estimate	Lower	Upper	Estimate	Lower	Upper	Sample
		Estimate	95% CI	95% CI	Estimate	95% CI	95% CI	
1978 to 2001	33,800	0	0	3,400	0	0	10	57
1960 to 1977	22,900	500	100	2,900	2	0	13	45
Before 1960	29,200	7,100	2,600	11,600	24	13	40	53
Unknown	14,100	3,900			27			13
Total Centers	100,000	11,400	4,100	18,700	11	6	20	168

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use number of centers in that row as the denominator

Figure 4-1 is a bar chart that summarizes the above survey data on deteriorated and significantly deteriorated LBP by construction year. It graphically displays the downward trend in the prevalence of LBP and of damaged LBP in centers, as year of construction increases.

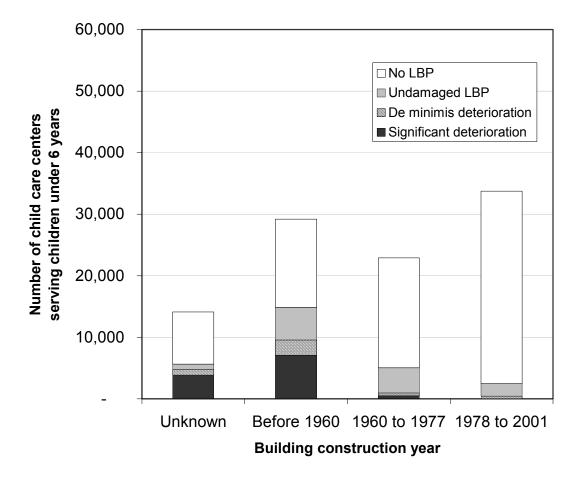


Figure 4-1. Presence and condition of LBP by construction year

#### 4.3 Paint Lead Loadings in Centers

Table 4-5 presents the distribution of the highest lead paint loading in each center by location in the building for selected thresholds: 0.3, 0.6, 0.7, 0.8, 1.0, 1.3, 4.0, and 10.0 mg/cm<sup>2</sup>. By statutory definition, paint with less than 1.0 mg/cm<sup>2</sup> is not LBP; thus, the first four categories include paint that is considered not to be LBP. The majority of the surfaces tested did not contain LBP. An estimated 28 percent of centers had at least one component painted with LBP. Nine percent of centers had at least one paint measurement with lead loading of 10 mg/cm<sup>2</sup> or more.

Table 4-5. Distribution of maximum paint lead loading by location in the building (all numbers represent the percent of all centers)

Maximum Paint Lead		Interior			Exterior			Anywhere	
Loading in Center	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI
No Paint (1)				12	8	18			
GT 0 mg/cm <sup>2</sup>	100			86	78	91	100		
$GE 0.3 \text{ mg/cm}^2$	47	39	56	30	23	38	54	45	62
$GE 0.6 \text{ mg/cm}^2$	30	23	38	23	16	31	37	30	45
$GE 0.7 \text{ mg/cm}^2$	27	20	35	22	16	30	34	27	42
$GE 0.8 \text{ mg/cm}^2$	24	17	31	22	16	30	31	25	38
$GE 1.0 \text{ mg/cm}^2$	21	15	27	20	14	28	28	22	35
GE 1.3 mg/cm <sup>2</sup>	15	10	22	15	10	22	23	17	29
$GE 4.0 \text{ mg/cm}^2$	10	6	18	10	6	16	15	10	21
GE 10.0 mg/cm <sup>2</sup>	6	3	13	7	3	13	9	5	15

<sup>(1)</sup> One center had exterior paint but no XRF measurement; 24 centers had no exterior paint

Values may not add up to the total due to rounding

Percentages use 99,952 centers as the denominator

Table 4-6 presents the distribution of paint lead loadings by location in the building and construction year for the selected thresholds. This clearly demonstrates the effectiveness of the reduction from 1940 to 1980 in the amount of lead added to commercial residential paint. An estimated 15 percent of centers in buildings reported as built before 1960 had at least one lead measurement somewhere in the center at 1.0 mg/cm², or above. This decreased to 5 percent of centers reported as built between 1960 and 1977, and to 2 percent of centers reported as built since 1978. The same pattern holds for very high lead levels, with 7 percent of pre-1960 centers having some lead above 10 mg/cm² but none for post-1960 centers.

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

GT = Greater than

GE = Greater than or equal to

Table 4-6. Distribution of paint lead loading by location in the child care center and construction year

	Percent of	Child Care Cer	nters with LBP		
Highest Paint Lead		Year of Co	onstruction		
Loading in the Child Care Center	1978 to 2001	1960 to 1977	Before 1960	Unknown	All Centers
Interior					
GE 0 mg/cm <sup>2</sup>	34	23	29	14	100
$GE 0.3 \text{ mg/cm}^2$	8	11	20	9	47
$GE 0.6 \text{ mg/cm}^2$	4	7	14	6	30
$GE 0.7 \text{ mg/cm}^2$	3	6	13	5	27
$GE 0.8 \text{ mg/cm}^2$	2	4	13	5	24
$GE 1.0 \text{ mg/cm}^2$	1	3	12	5	21
GE $1.3 \text{ mg/cm}^2$	0	2	10	3	15
$GE 4.0 \text{ mg/cm}^2$	0	1	7	3	10
GE 10.0 mg/cm <sup>2</sup>	0	0	5	1	6
Exterior					
No Exterior Paint (1)	5	2	4	1	12
GE 0 mg/cm <sup>2</sup>	29	21	23	13	86
$GE 0.3 \text{ mg/cm}^2$	5	7	13	6	30
$GE 0.6 \text{ mg/cm}^2$	2	5	10	6	23
$GE 0.7 \text{ mg/cm}^2$	2	4	10	6	22
$GE 0.8 \text{ mg/cm}^2$	2	4	10	6	22
$GE 1.0 \text{ mg/cm}^2$	2	3	9	6	20
GE $1.3 \text{ mg/cm}^2$	1	1	9	4	15
$GE 4.0 \text{ mg/cm}^2$	0	0	6	4	10
GE 10.0 mg/cm <sup>2</sup>	0	0	5	2	7
Anywhere in Building					
GE 0 mg/cm <sup>2</sup>	34	23	29	14	100
$GE 0.3 \text{ mg/cm}^2$	9	12	22	10	54
$GE 0.6 \text{ mg/cm}^2$	6	9	16	7	37
$GE 0.7 \text{ mg/cm}^2$	5	8	15	6	34
GE $0.8 \text{ mg/cm}^2$	4	6	15	6	31
$GE 1.0 \text{ mg/cm}^2$	2	5	15	6	28
GE 1.3 $mg/cm^2$	1	3	14	4	23
$GE 4.0 \text{ mg/cm}^2$	0	1	10	4	15
GE 10.0 mg/cm <sup>2</sup>	0	0	7	2	9

<sup>(1)</sup> One center had exterior paint but no XRF measurement; 24 centers had no exterior paint

Values may not add up to the total due to rounding

Percentages use 99,952 centers as the denominator

<sup>(2)</sup> Negative XRF readings were assumed to be zero for this table.

GE= Greater than or equal to

Tables 4-7 and 4-8 present selected parameters of the distributions of paint lead loadings for interior and exterior component types. All of the distributions in the tables are right-skewed with many zero values and thus cannot be reasonably fitted by normal or log-normal distributions.

Table 4-7. Estimated empirical distribution parameters of paint lead loading by interior component types

	Walls and Floors	Windows	Doors	Trim	Toys/Play Equipment	Other
	mg/cm <sup>2</sup>	mg/cm <sup>2</sup>	mg/cm <sup>2</sup>	mg/cm <sup>2</sup>	mg/cm <sup>2</sup>	mg/cm <sup>2</sup>
Arithmetic Mean	0.12	0.78	0.12	0.42	0.02	0.17
Arithmetic Standard Deviation	1.17	3.90	1.46	2.16	0.09	1.05
25th Percentile	0	0	0	0	0	0
Median	0	0	0	0	0	0
75th Percentile	0	0	0	0	0	0
90th Percentile	0.1	0.4	0.1	0.2	0.1	0.2
95th Percentile	0.3	3	0.2	1.3	0.1	0.5
Maximum	31	44	32	20	0.9	11
Number of Readings	2407	442	856	257	213	228

The geometric mean and standard deviation were not calculated due to the large number of zero readings.

Table 4-8. Estimated empirical distribution parameters of paint lead loading by exterior component types

	Walls	Windows	Doors	Trim	Porch	Play Equipment	Other
	mg/cm <sup>2</sup>						
Arithmetic Mean	0.96	1.93	1.07	0.37	0.12	0.06	4.23
Arithmetic Standard Deviation	5.03	6.14	4.77	2.10	0.49	0.32	14.95
25th Percentile	0	0	0	0	0	0	0
Median	0	0	0	0	0	0	0
75th Percentile	0	0.1	0.1	0	0	0	0
90th Percentile	0.2	3.2	0.9	0.1	0.1	0.1	5.7
95th Percentile	2.5	21	3.7	0.2	1.1	0.3	58
Maximum	34	28	42	14	3.1	3.4	58
Number of Readings	164	85	187	46	66	172	15

The geometric mean and standard deviation were not calculated due to the large number of zero readings.

Table 4-9 summarizes the data in Tables 4-7 and 4-8 by presenting the percentage of rooms with components with LBP by component type and center age. It also shows the expected trends and differences with older buildings having more LBP than newer ones.

Table 4-9. Percentage of rooms/centers with LBP by component type and child care center year of construction

Component Type		Year of Con	struction		
Component Type	1978 to 2001	1960 to 1977	Before 1960	Unknown	All Centers
Interior Walls or Floors	0	6	9	11	5
Windows	0	2	13	14	7
Doors	0	1	7	4	3
Trim	0	3	8	18	5
Other	2	2	5	6	3
All Interior Components	1	8	24	20	12
Exterior Walls	2	0	8	8	4
Windows	0	2	11	8	5
Doors	2	7	15	23	9
Trim	0	0	4	0	1
Porch	0	0	8	0	2
Play Equipment	2	2	2	0	2
Other	0	0	0	100	15
All Exterior Components	5	11	28	38	17

For interior components, percentages use the number of rooms as the denominator. For exterior components, percentages use the number of centers as the denominator.

#### 4.4 Amount of Lead-Based Paint in Centers

Table 4-10 presents estimates of the area of LBP by architectural component type. The first portion of the table shows the square feet of LBP; the second portion shows the area of LBP as percent of the area of all painted surfaces, and the third portion presents the average area of LBP for those centers with any LBP. An estimated 11.8 million square feet of painted interior surfaces are covered with LBP. This represents only 3 percent of the area of painted interior surfaces in all centers. Although 3 percent of paint on walls, floors, and ceilings is LBP, the area of these LBP-coated components accounts for 62 percent (7.27/11.78) of all interior surfaces with LBP. Conversely, 32 percent of paint on trim contains LBP, but the total surface area of LBP on trim is only 25 percent of the area of all interior painted surfaces.

An estimated 18.1 million square feet of painted exterior surfaces are covered with LBP. This represents 13 percent of the area of painted exterior surfaces in all centers. Exterior walls account for 90 percent (16.26/18.07) of the exterior surface area of LBP.

Of those centers with LBP, most have relatively small areas of LBP. The average center with LBP has 421 square feet of interior LBP and 645 square feet of exterior LBP.<sup>2</sup>

Table 4-10a. Amount of LBP by painted component

Component		Millions	of Square Feet	of LBP	
Component	1978 to 2001	1960 to 1977	Before 1960	Unknown	All Centers
Interior Wall, Floor, Ceiling	0.00	3.15	1.75	2.37	7.27
Window	0.00	0.01	0.14	0.27	0.42
Door	0.00	0.01	0.15	0.16	0.32
Trim	0.00	0.01	0.20	2.79	3.00
Other	0.02	0.01	0.62	0.10	0.75
TOTAL	0.02	3.19	2.87	5.70	11.78
Exterior Wall	1.83	0.00	13.78	0.65	16.26
Window	0.00	0.00	0.54	0.10	0.65
Door	0.00	0.02	0.07	0.06	0.15
Trim	0.00	0.00	0.12	0.00	0.12
Porch	0.00	0.00	0.67	0.00	0.67
Play Equipment	0.11	0.00	0.00	0.00	0.11
Other	0.00	0.00	0.00	0.11	0.11
TOTAL	1.95	0.03	15.18	0.92	18.07

Values may not add up to the total due to rounding

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<sup>&</sup>lt;sup>2</sup> For comparison, a room 10' x 12' with an 8' ceiling has a wall area of 352 square feet and a combined wall, ceiling, and floor area of 592 square feet.

Table 4-10b. Percentage of painted area with LBP by painted component

Component	Are	a of LBP as Perc	ent of All Paint	on the Compo	nent
Component	1978 to 2001	1960 to 1977	Before 1960	Unknown	All Centers
Interior Wall, Floor, Ceiling	0	5	2	4	3
Window	0	1	5	25	6
Door	0	0	2	4	1
Trim	0	1	8	71	32
Other	1	0	8	2	4
TOTAL	0	4	3	7	3
Exterior Wall	5	0	39	14	14
Window	0	1	35	92	20
Door	1	5	13	22	9
Trim	0	0	17	0	4
Porch	0	0	14	0	5
Play Equipment	34	0	0	0	15
Other	0	0	0	100	18
TOTAL	4	0	35	16	13

Percentages use the area of paint in the cell as the denominator

Table 4-10c. Average area of LBP in centers with LBP by painted component

Component	Aver	age Amount LB	P per Center wit	h LBP (square	feet)
Component	1978 to 2001	1960 to 1977	Before 1960	Unknown	All Centers
Interior Wall, Floor, Ceiling	0	626	118	421	260
Window	0	2	10	48	15
Door	0	3	10	29	11
Trim	0	2	14	495	107
Other	8	2	42	18	27
TOTAL	8	635	193	1011	421
Exterior Wall	744	0	927	115	581
Window	0	1	36	18	23
Door	1	5	5	10	5
Trim	0	0	8	0	4
Porch	0	0	45	0	24
Play Equipment	45	0	0	0	4
Other	0	0	0	19	4
TOTAL	790	5	1021	163	645

Values may not add to the total due to rounding

# 4.5 Comparison of Lead-Based Paint Prevalence Between Child Care Centers and Homes

Table 4-11 shows comparable estimates of the prevalence of LBP and deteriorated LBP between child care centers and homes (based on the National Survey of Lead and Allergens in Housing).

Age, region, and urbanization categories were combined to calculate comparable estimates between the two surveys. In general, a higher percent of homes have LBP than child care centers. Forty percent of homes have LBP while only 28 percent of child care centers have LBP. The trends by construction year category and region are similar. However, for buildings built since 1960, a higher proportion of child care centers have LBP than homes. This is likely due to the reductions in lead levels required for residential paint. The relative differences between MSA/non-MSA areas are different for the two surveys. A greater percentage of child care centers have LBP in MSAs compared to rural areas. A slightly higher proportion of homes have deteriorated LBP and significantly deteriorated LBP (18% and 14% respectively) than child care centers (16% and 11% respectively).

Table 4-11. Comparison of the prevalence of LBP and LBP hazards between child care centers and homes, by building characteristic

			Percent v	vith LBP		
Child Care Center/Home	Chile	d Care Cer			Homes	
Characteristics	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI
All Centers or Homes	28	22	35	40	36	43
Construction Year						
1978 - 2001	7	3	16	7	2	12
1960 - 1977	22	14	34	24	18	30
Before 1960	51	38	63	77	72	82
Unknown	40					
Region						
Northeast/Midwest	33	24	43	54	49	59
South/West	24	16	34	29	25	33
Urbanization						
MSA	30	23	39	47	35	59
Rural	18	10	29	37	33	41
Majority Race						
White	20	12	32	40	37	44
African American	40	24	59	41	30	52
Other	29	11	58	29	17	41
Refusal/Don't Know	45					
		Percei	nt with De	teriorated	LBP	
All Centers or Homes	16	10	24	18	16	20
	Pe	rcent with	Significa	ntly Deteri	orated LE	BP
All Centers or Homes	11	6	20	14	12	17

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#### 5. DUST LEAD IN CHILD CARE CENTERS

Chapter 5 presents estimates of the prevalence of lead-contaminated dust in licensed child care centers (CCCs), including the dust lead loadings and the association between interior dust lead and interior lead-based paint (LBP) condition.

#### 5.1 Prevalence of Dust Lead in Child Care Centers

Table 5-1 presents the prevalence of centers with a dust lead hazard somewhere in the center. A dust lead hazard is defined as greater than or equal to  $40 \mu g/ft^2$  lead on floors or  $250 \mu g/ft^2$  lead on interior window sills. An estimated 3 percent  $(1\% \text{ to } 7\%)^2$  of all licensed CCCs in the continental United States have a dust lead hazard somewhere in the center. However, due to the small number of centers with a dust lead hazard, it is not possible to further characterize the centers with dust lead hazards.

<sup>&</sup>lt;sup>1</sup> The maximum lead dust loading on any surface tested (separately for floor and window sill) in the center was used to determine whether a dust lead hazard existed.

<sup>&</sup>lt;sup>2</sup> 95% confidence intervals are shown in parentheses.

Table 5-1. Prevalence of child care centers with a dust lead hazard by characteristics

Child Care Center Characteristics	Number of		f Centers v Lead Hazar	with a Dust rd	Perc	ent of Cen	ters	Centers in
Clind Care Center Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
Total Centers	100,000	2,800	300	5,400	3	1	7	168
Construction Year								
1978 to 2001	33,800	1,200	300	4,200	3	1	12	57
1960 to 1977	22,900	800	100	4,100	3	1	18	45
Before 1960	29,200	900	200	3,700	3	1	13	53
Unknown	14,100	0			0			13
Region								
Northeast/Midwest	45,200	1,500	500	4,400	3	1	10	79
South/West	54,800	1,300	300	4,900	2	1	9	89
Region by Construction Year								
Northeast/Midwest								
1978 to 2001	12,100	600	100	3,200	5	1	26	23
1960 to 1977	9,700	0	0	2,400	0	0	25	19
Before 1960	17,900	900	200	3,600	5	1	20	31
Unknown	5,400	0			0			6
South/West								
1978 to 2001	21,600	600	100	3,100	3	0	14	34
1960 to 1977	13,200	800	100	3,800	6	1	29	26
Before 1960	11,300	0	0	2,500	0	0	22	22
Unknown	8,700	0			0			7
Urbanization								
MSA Central City	51,200	1,500	500	4,300	3	1	8	83
Other MSA	26,600	0	0	3,500	0	0	13	42
Rural	22,200	1,400	400	4,400	6	2	20	43
Majority Race								
White	51,300	1,500	500	4,200	3	1	8	96
African American	26,800	600	100	3,400	2	0	13	37
Other	19,200	0	0	3,300	0	0	17	31
Refusal/Don't Know	2,700	800			28			4

Table 5-1. Prevalence of child care centers with a dust lead hazard by characteristics (continued)

Child Care Center Characteristics	Number of		of Centers Lead Haza	with a Dust rd	Perc	ent of Cen	ters	Centers in
Child Care Center Characteristics	Centers	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	Sample
<b>Percent of Children Getting Govt.</b>								
Subsidy								
Greater than 50%	28,900	900	200	3,500	3	1	12	44
1% - 50%	39,200	0	0	3,100	0	0	8	73
None	25,800	1,200	400	3,500	5	1	14	41
Refusal/Don't Know	6,000	800			13			10
Percent of Operating Costs from								
Govt. Subsidy								
Greater than 50%	22,200	300	0	1,900	1	0	8	36
1% - 50%	26,700	600	100	3,200	2	0	12	47
None	35,000	1,200	400	3,600	3	1	10	62
Refusal/Don't Know	16,000	800			5			23
Headstart Program								
Yes	9,000	0	0	2,800	0	0	31	14
No	89,400	2,100	0	4,100	2	1	6	152
Refusal/Don't Know	1,500	800			50			2
Center Ownership								
Private	78,900	2,100	0	4,100	3	1	7	134
Government	19,200	0	0	3,300	0	0	17	31
Refusal/Don't Know	1,800	800			41			3
<b>Center Ever Tested for Lead</b>								
Yes	19,500	300	0	1,800	2	0	9	34
No	65,800	1,800	600	5,100	3	1	8	111
Refusal/Don't Know	14,600	800			5			23
Children Required to Have Blood								
Test for Lead								
Yes	19,400	0	0	3,300	0	0	17	31
No	73,800	2,100	0	4,100	3	1	7	127
Refusal/Don't Know	6,800	800			11			10

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

MSA = Metropolitan Statistical Area, the "MSA Central City" includes the county in which the MSA central city is located Percentages use the number of centers (left end of the row) as the denominator

### **5.2 Dust Lead Loadings in Child Care Centers**

Tables 5-2a and 5-2b present information on maximum and average dust loadings, respectively, by surface. Table 5-2a presents the distribution of maximum dust lead loadings by surface (floor and window sill) for all centers in the target population, for selected threshold values. In most of the centers the maximum floor dust lead loading is below the limit of detection<sup>3</sup>. In almost all centers the maximum floor dust lead loading is also less than the reporting limit.<sup>4</sup> None of the centers have maximum floor dust lead loadings above the standard of 40  $\mu$ g/ft<sup>2</sup>. An estimated 25 percent of all centers have sill dust lead loadings above the reporting limit, but only 3 percent are above the standard of 250  $\mu$ g/ft<sup>2</sup>. The low numbers of centers with lead dust hazard may be due to the frequent (at least daily) cleaning that licensed CCCs are required to or often conduct.

Table 5-2b presents the distribution of average dust lead loadings by surface (floor and window sill) for all centers in the target population. The average dust loading for each center was determined by simply adding the dust loadings for each room sampled in each center and dividing by the number of rooms sampled (unweighted average).<sup>5</sup>

The same trends are observed in Table 5-2b for average dust lead loadings as for the distribution of maximum dust lead loadings in Table 5-2a. Only 1 percent of centers have average window sill loadings above 250  $\mu$ g/ft.

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<sup>&</sup>lt;sup>3</sup> The average analytical detection limit for each wipe sample was 3.5 μg. While detection limits for each surface are area dependent, this corresponds to a detection limit of 3.5 μg/ft<sup>2</sup> for a one square foot floor sample or 7 μg/ft<sup>2</sup> for a typical 3" x 24" sill sample.

 $<sup>^4</sup>$  The lowest lead value a lab can confidently report for the wipe samples. The reporting limit was 10  $\mu g$ . While reporting limits for each surface are area dependent, this corresponds to a reporting limit of 10  $\mu g/ft^2$  for a 1 square foot floor sample or 20  $\mu g/ft^2$  for a typical 3" x 24" sill sample.

<sup>&</sup>lt;sup>5</sup> For averaging floor samples, only carpeted floor samples and uncarpeted floor samples were combined for the respective average (carpeted or uncarpeted).

Table 5-2a. Distribution of maximum dust lead loading by surface

Maximum Dust Lead Loading in	Nur	nber of Ce	nters	Percent of Centers (%)			
Child Care Center (□g/sq ft)	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	
Floors							
LT LOD	73,700	62,400	84,900	74	64	82	
GE LOD	26,300	16,200	36,400	26	18	36	
GE Reporting limit	1,100	300	4,200	1	0	4	
GE 20	600	100	3,700	1	0	4	
GE 40	0	0	3,600	0	0	4	
GE 100	0	0	3,600	0	0	4	
Window Sills							
LT LOD	30,200	22,500	38,000	30	23	38	
GE LOD	55,300	44,100	66,500	55	48	62	
GE Reporting limit	24,800	16,100	33,600	25	18	34	
GE 125	4,700	900	8,600	5	2	10	
GE 250	2,800	300	5,400	3	1	7	
GE 500	600	100	3,600	1	0	4	
No sill present in Sampled Rooms	10,700	6,000	15,500	11	7	16	
Missing/Inaccessible	3,600			4	1	9	

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

LT LOD = Less than the limit of detection

GE LOD = Greater than or equal to the limit of detection

Reporting limit = The lowest lead value a lab can confidently report for the wipe samples. The reporting limit was 10  $\mu$ g. While reporting limits for each surface are area dependent, this corresponds to a reporting limit of 10  $\mu$ g/ft<sup>2</sup> for a 1 square foot floor sample or 20  $\mu$ g/ft<sup>2</sup> for a typical 3" x 24" sill sample.

Table 5-2b. Distribution of average dust lead loading by surface

Average Dust Lead Loading in	Num	ber of Cent	ters	Percent of Centers (%)			
Child Care Center (□g/sq ft)	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI	
Floors (Uncarpeted)							
LT LOD	54,600	44,600	64,600	55	47	62	
GE LOD	14,200	8,800	19,700	14	10	20	
GE Reporting limit	600	100	3,700	1	0	4	
GE 20	600	100	3,700	1	0	4	
GE 40	0	0	3,600	0	0	4	
GE 100	0	0	3,600	0	0	4	
No uncarpeted floors present	31,100	24,700	37,500	31	25	38	
Floors (Carpeted)							
LT LOD	43,100	33,600	52,500	43	36	51	
GE LOD	7,500	3,200	11,800	8	4	13	
GE Reporting limit	0	0	3,600	0	0	4	
GE 20	0	0	3,600	0	0	4	
GE 40	0	0	3,600	0	0	4	
GE 100	0	0	3,600	0	0	4	
No carpeted floors present	49,400	40,300	58,400	49	42	56	
Window Sills							
LT LOD	35,800	27,800	43,800	36	29	43	
GE LOD	49,800	40,100	59,400	50	44	56	
GE Reporting limit	18,400	10,800	26,000	18	12	27	
GE 125	3,400	700	6,000	3	2	7	
GE 250	1,200	300	4,200	1	0	4	
GE 500	600	100	3,600	1	0	4	
No sill present in Center	10,700	6,000	15,500	11	7	16	
Missing  CL = Confidence limit for a 050% confiden	3,600			4			

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Percentages use 99,952 centers as the denominator

Reporting limit = The lowest lead value a lab can confidently report for the wipe samples. The reporting limit was 10  $\mu$ g. While reporting limits for each surface are area dependent, this corresponds to a reporting limit of 10  $\mu$ g/ft<sup>2</sup> for a 1 square foot floor sample or 20  $\mu$ g/ft<sup>2</sup> for a typical 3" x 24" sill sample.

Table 5-3 presents the distribution of dust lead loadings by room type and surface for selected threshold values. The vast majority of floors had undetectable levels of dust lead. None of the classrooms and only 3 percent of multipurpose rooms had floor dust lead levels above 20  $\mu g/ft^2$ . One

LT LOD = Less than the limit of detection

GE LOD = Greater than or equal to the limit of detection

percent of classrooms and 2 percent of multipurpose rooms had window sill dust lead levels above the standard for window sills.

Table 5-4 presents the maximum window sill dust lead loading, by selected thresholds and by year of construction. Note that while many more centers built before 1960 have window sill dust above reporting limits, there are similar rates for all aged buildings with maximum window sill dust lead loading exceeding the standard of 250  $\mu$ g/ft.

Table 5-3. Distribution of dust lead loading by room and surfaces

Dust Lead Loading	Class	room	Multipur	pose Room	All R	ooms
(μg/sq ft)	Number of	Percent of	Number of	Percent of	Number of	Percent of
(1.5 - 1 - )	Rooms	Rooms (%)	Rooms	Rooms (%)	Rooms	Rooms (%)
Floors						
LT LOD	250,200	82	51,400	78	301,600	81
GE LOD	54,500	18	14,800	22	69,200	19
GE Reporting Limit	1,400	1	1,800	3	3,200	1
GE 20	0	0	1,800	3	1,800	1
GE 40	0	0	0	0	0	0
GE 100	0	0	0	0	0	0
Missing	0	0	0	0	0	0
Total Rooms	304,600	100	66,100	100	370,800	100
Window Sills						
LT LOD	128,300	42	21,000	32	149,300	40
GE LOD	131,400	43	27,300	41	158,800	43
GE Reporting Limit	50,600	17	12,100	18	62,700	17
GE 125	6,700	2	1,500	2	8,200	2
GE 250	2,700	1	1,500	2	4,300	1
GE 500	600	0	0	0	600	0
Missing	3,000	1	5,400	8	8,500	2
No Sills	41,900	14	12,400	19	54,300	15
Total Rooms	304,600	100	66,100	100	370,800	100

Values may not add to the total due to rounding

Percentages use the number of rooms (304,600, 66,100, or 370,800) as the denominator

LT LOD = Less than the limit of detection

GE LOD = Greater than or equal to the limit of detection

Reporting limit = The lowest lead value a lab can confidently report for the wipe samples. The reporting limit was 10  $\mu$ g. While reporting limits for each surface are area dependent, this corresponds to a reporting limit of 10  $\mu$ g/ft<sup>2</sup> for a 1 square foot floor sample or 20  $\mu$ g/ft<sup>2</sup> for a typical 3" x 24" sill sample.

Table 5-4. Maximum window sill dust lead loading by year of construction

Maximum	Window Sill Lead				Year of Co	nstruction				All C	antara
		1978 to	2001	1960 t	o 1977	Before	1960	Unkr	own	All C	enters
Loau	ing (μg/sq ft)	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
LT LOD	Number Centers	13,700	41	7,400	32	8,000	27	1,200	8	30,200	30
	Lower 95% CI	7,700	25	2,900	18	5,300	20	16,800	1	22,500	23
	Upper 95% CI	19,700	58	11,900	51	10,700	37	5,600	40	38,000	38
GE LOD	Number Centers	12,600	37	12,000	52	19,900	68	10,800	76	55,300	55
	Lower 95% CI	5,900	23	7,100	39	14,000	58	5,400	47	44,100	48
	Upper 95% CI	19,300	54	16,900	66	25,800	77	16,100	92	66,500	62
GE	Number Centers	4,700	14	3,500	15	11,200	38	5,400	38	24,800	25
Reporting	Lower 95% CI	1,400	7	100	6	5,900	25	900	16	16,100	18
Limit	Upper 95% CI	8,000	26	6,900	34	16,500	54	9,900	67	33,600	34
GE 125	Number Centers	1,200	3	800	3	2,800	10	0	0	4,700	5
	Lower 95% CI	300	1	100	1	900	3	0	0	900	2
	Upper 95% CI	4,200	12	6,900	18	7,900	27	4,600	33	8,600	10
GE 250	Number Centers	1,200	3	800	3	900	3	0	0	2,800	3
	Lower 95% CI	300	1	100	1	200	1	0	0	300	1
	Upper 95% CI	4,200	12	4,100	18	3,700	13	4,600	33	5,400	7
GE 500	Number Centers	600	2	0	0	0	0	0	0	600	1
	Lower 95% CI	100	0	0	0	0	0	0	0	100	0
	Upper 95% CI	3,500	10	1,800	12	2,000	11	4,600	33	3,600	4
Missing	Number Centers	1,500	4	1,200	5	0	0	900	7	3,600	4
No Sills	Number Centers	5,900	18	2,300	10	1,300	4	1,300	9	10,700	11
	Lower 95% CI	2,500	10	200	4	39,500	1	19,100	1	6,000	7
	Upper 95% CI	9,400	29	4,400	23	4,000	14	5,800	41	15,500	16

Percent is number of centers as a percentage of all centers in the construction year category.

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

LT LOD = Less than the limit of detection

GE LOD = Greater than or equal to the limit of detection

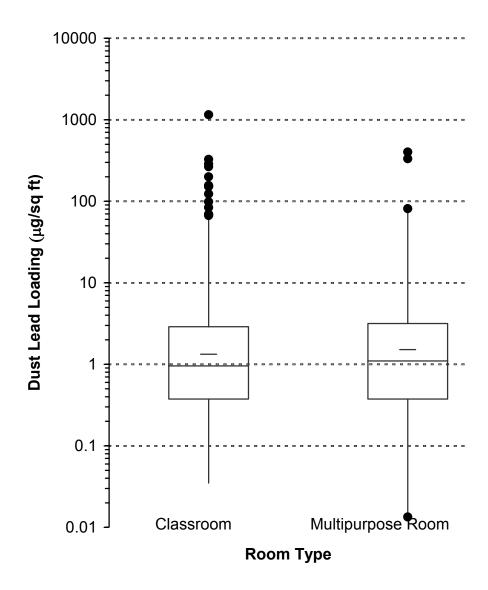
Values may not add to the total due to rounding

Reporting limit = The lowest lead value a lab can confidently report for the wipe samples. The reporting limit was 10  $\mu$ g. While reporting limits for each surface are area dependent, this corresponds to a reporting limit of 10  $\mu$ g/ft<sup>2</sup> for a 1 square foot floor sample or 20  $\mu$ g/ft<sup>2</sup> for a typical 3" x 24" sill sample.

Figure 5-1 shows the distribution of the dust lead loadings by room type: classroom and multipurpose. Figure 5-2 shows the distribution of the dust lead measurements by surface. In both figures, the distributions are somewhat right-skewed even after using the log transformation. None of the boxes extend above 40  $\mu$ g/ft², which means that the 75th percentile is less than 40  $\mu$ g/ft². However, there are window sill dust lead loadings well above 100  $\mu$ g/ft².

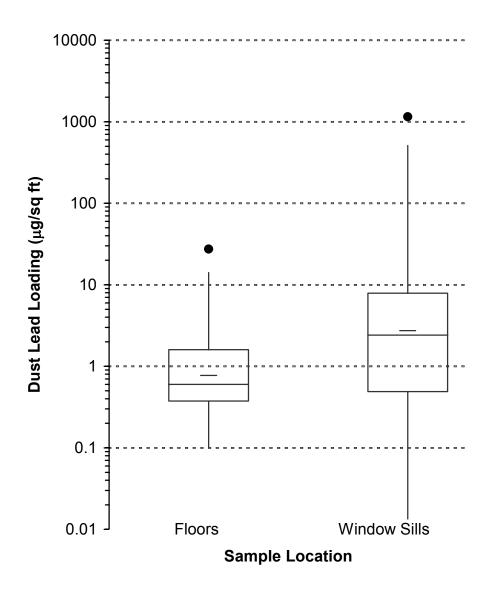
Table 5-5 presents selected parameters of the distributions of dust lead loadings by surface types, corresponding to the box plots in Figure 5-2. Table 5-5 also presents geometric means and standard deviations. The distributions in Table 5-5 are all right-skewed, so that they are not normally distributed. A better model would be the log-normal distribution.

Figure 5-1. Box plots for dust lead loading by room



Paint and dust lead loading data are presented in box plot form. Each box plot shows a univariate data distribution, for example, the dust samples collected from a specific sample location (e.g., classroom). The box in the box plot represents the middle 50 percent of the data; the bottom of the box gives the 25th percentile; the top gives the 75th percentile; and the horizontal line inside the box gives the median or 50th percentile. The vertical lines (whiskers) from the top and bottom of the box extend 1.5 times the length of the box or to the largest and smallest observations, whichever is closer. Individual observations beyond the whiskers are shown as dots. Data sets approximating a log-normal distribution will produce a symmetrical box plot since the data are plotted on a logscale. From this display of the data, it is possible to visually compare lead loadings between classrooms and multipurpose rooms.

Figure 5-2. Box plots for dust lead loading by surface



Paint and dust lead loading data are presented in box plot form. Each box plot shows a univariate data distribution, for example, the dust samples collected from a specific sample location (e.g., classroom floor). The box in the box plot represents the middle 50 percent of the data; the bottom of the box gives the 25th percentile; the top gives the 75th percentile; and the horizontal line inside the box gives the median or 50th percentile. The vertical lines (whiskers) from the top and bottom of the box extend 1.5 times the length of the box or to the largest and smallest observations, whichever is closer. Individual observations beyond the whiskers are shown as dots. Data sets approximating a log-normal distribution will produce a symmetrical box plot since the data are plotted on a logscale. From this display of the data, it is possible to visually compare lead loadings between floors and window sills.

Table 5-5. Estimated empirical distribution parameters of dust lead loading by surface types

	Floors	Window Sills
	$\mu g/ft^2$	μg/ft <sup>2</sup>
Arithmetic Mean	1.3	20.5
Arithmetic Standard Deviation	2.0	84.6
Geometric Mean	0.8	2.7
Geometric Standard Deviation	2.5	6.3
25th Percentile	0.4	0.5
Median	0.6	2.4
75th Percentile	1.6	7.9
90th Percentile	2.6	31.3
95th Percentile	3.9	81.3
Maximum	27.5	1154.7
Number of Samples	336	273

For these calculations, negative and zero values were replaced by 0.375.

# 5.3 Association between Interior Dust Lead Hazards and Interior and Exterior Lead-Based Paint Condition

Table 5-6 presents the prevalence of interior dust lead hazards in relation to the condition of the interior and exterior LBP. Dust lead hazards are more likely to exist in homes with interior LBP<sup>6</sup>, and the same is probably true in centers. An estimated 7 percent of centers with significantly deteriorated interior LBP (6 percent of centers with interior LBP in good condition) have lead dust hazards. Only 2 percent of centers with no interior LBP have lead dust hazards. Given the small number of sampled centers, this relationship is not strong. Although it appears from the data that the presence of interior LBP is correlated with higher dust lead hazard, there are additional sources of lead in the environment to account for dust lead in centers with no LBP. Dust lead hazards are due to sill dust in this survey. In homes, interior LBP condition is more highly correlated with interior floor lead. Apparently because of required daily cleaning in the centers, this association was not observed in CCCs.

Exterior LBP may contribute to interior dust lead, particularly on window sills that are the primary source of dust hazards in CCCs. However, the data show no apparent relationship between the presence and condition of exterior LBP and the interior dust lead hazards.

<sup>&</sup>lt;sup>6</sup> National Survey of Lead and Allergens in Housing, Volume 1: Analysis of Lead Hazards, Final Report, October 31, 2002, U.S. Department of Housing and Urban Development.

Table 5-6. Association between dust lead hazards and presence and condition of interior and exterior LBP

		т.	, IDD				
		In	terior LBP		1		
		No Inter	ior LBP	Interior LB Cond		Significantly Deteriorated Interior LBP	
		Number	Percent	Number	Percent	Number	Percent
No Interior Dust Lead	Estimate	77,800	98	14,900	95	4,500	94
Hazards	Lower 95% CI	67,000	94	9,400	79	267,700	56
Hazaius	Upper 95% CI	88,600	99	20,300	99	474,700	99
Interior Dust Lead	Estimate	1,700	2	900	6	300	7
Hazards	Lower 95% CI	52,200	1	19,300	1	2,900	1
	Upper 95% CI	510,800	6	334,000	21	209,900	44
Number of Centers	Estimate	79,400	100	15,700	100	4,800	100
		Ex	terior LBP				
		No Exterior LBP		Exterior LBP in Good Condition		Significantly Deteriorated Exterior LBP	
		Number	Percent	Number	Percent	Number	Percent
No Interior Dust Lead	Estimate	77,600	97	9,500	97	10,000	100
Hazards	Lower 95% CI	66,700	92	4,000	81	3,500	65
nazaius	Upper 95% CI	88,600	99	14,900	100	16,600	100
Intonion Dust Load	Estimate	2,500	3	300	3	0	0
Interior Dust Lead Hazards	Lower 95% CI	0	1	0	0	0	0
	Upper 95% CI	5,100	8	1,800	19	1,700	35
Number of Centers	Estimate	80,200	100	9,800	100	10,000	100

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use the number of centers in the bottom row of the section as the denominator

# 5.4 Comparison of Dust Lead Hazard Prevalence Between Child Care Centers and Homes

Dust lead hazards are found more often in homes than in child care centers. An estimated three percent (one to seven percent) of CCCs have dust lead hazards and no hazards were found on floors. In comparison, 16 percent (14 to 19 percent) of homes were found to have dust lead hazards. Dust lead hazards on floors were found in 6 percent of homes and hazards due to sills were found in 14 percent of homes. Thus dust lead hazards due to sill dust is more common than due to floor dust, in both homes and CCCs.

#### 6. CHILD CARE CENTER SOIL LEAD

Chapter 6 presents estimates of the prevalence of soil lead and the association between soil lead concentration and exterior lead-based paint (LBP) condition. The prevalence of soil lead hazards in child care centers (CCCs) is presented in Chapter 3.

#### 6.1 Prevalence of Soil Lead

A soil sample was collected on the property of each CCC in children's play area(s). Each sample was a composite sample from three to five locations around the play area(s). Bare soil was sampled preferentially.

Table 6-1 presents the number and percentage of centers by selected soil lead concentration thresholds: LOD<sup>1</sup>, 50, 200, 400, 1,200, 1,600, 2,000, and 5,000 parts per million (ppm). Table 6-1 includes all soil, whether bare or covered. An estimated 48 percent (40% to 55%) of licensed CCCs in the continental United States have soil lead levels above the limit of detection, but only an estimated 2 percent (1% to 6%)<sup>2</sup> of centers have soil lead levels above 400 ppm, the current U.S. Department of Housing and Urban Development (HUD)/U.S. Environmental Protection Agency (EPA) standard.

<sup>&</sup>lt;sup>1</sup> The sample limit of detection for this study was determined to be 20 parts per million (ppm) by testing four distinct soil types from among the National Survey of Lead and Allergens in Housing (NSLAH) study samples in accordance with EPA SW 840 Method 3050 procedures.

<sup>&</sup>lt;sup>2</sup> 95% confidence intervals are shown in parentheses.

Table 6-1. Distribution of soil sample (bare and covered) lead concentrations

	N	Number of Cen	ters	Percent of Centers			
Soil Lead	Estimate	Lower 95%	Upper 95%	Estimate	Lower	Upper	
	Estimate	CI	CI	Estimate	95% CI	95% CI	
GE 0 ppm	71,900	60,400	83,500	72	62	80	
GE LOD (20 ppm)	47,800	38,700	56,800	48	40	55	
GE 50 ppm	20,600	10,200	31,000	21	12	32	
GE 200 ppm	6,200	500	11,900	6	3	14	
GE 400 ppm	2,100	700	6,400	2	1	6	
GE 1,200 ppm	300	100	2,000	0	0	2	
GE 1,600 ppm	300	100	2,000	0	0	2	
GE 2,000 ppm	300	100	2,000	0	0	2	
GE 5,000 ppm	0	0	3,700	0	0	4	
Missing	600			1			
No Soil in Play Area	23,400	12,800	33,900	23	15	34	
No Play Area	4,100	900	7,200	4	2	9	
Total	100,000	87,600	112,300	100			

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Percentages use 99,952 centers as the denominator

GE = Greater than or equal to

Table 6-2 presents the number and percentage of centers by selected soil lead concentration thresholds for bare soil only. Only two percent of centers were found to have bare soil lead above 400 ppm.

Values may not add to the total due to rounding

Table 6-2. Distribution of soil sample (bare soil only) lead concentrations

	N	umber of Cen	ters	Percent of Centers			
Soil Lead	Estimate	Lower 95% CI	wer 95% Upper 95% CI CI		Lower 95% CI	Upper 95% CI	
GE 0 nnm	68,400	58,000	78,700	68	59	76	
GE 0 ppm	<b>,</b>	*	,	08		70	
GE LOD (20 ppm)	46,000	37,700	54,400	46	39	54	
GE 50 ppm	20,200	10,200	30,100	20	12	31	
GE 200 ppm	6,200	500	11,900	6	3	14	
GE 400 ppm	2,100	700	6,400	2	1	6	
GE 1,200 ppm	300	100	2,000	0	0	2	
Missing	600			1			
No Bare Soil	3,600	100	7,000	4	1	9	
No Soil in Play Area	23,400	12,800	33,900	23	15	34	
No Play Area	4,100	900	7,200	4	2	9	
Total	100,000	87,600	112,300	100			

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

GE = Greater than or equal to

Table 6-3 presents the number and percentage of centers by construction year for selected soil lead concentration thresholds for all soil, whether bare or covered. With the exception of one sampled post-1978 center with high soil lead concentrations, in general, buildings build before 1960 tend to have higher soil concentrations.

Table 6-3. Distribution of soil sample (bare and covered) lead concentrations by construction year

Cail Land	Number of Centers					Percent of Centers				
Soil Lead	Before	1960 to	1978 to	Unlmovem	All Centers	Before	1960 to	1978 to	Unknoven	All Centers
Concentration	1960	1977	2001	Unknown	All Centers	1960	960 1977	2001	Unknown	All Celliers
GE 0 ppm	21,000	15,600	23,700	11,600	71,900	72	68	70	82	72
GE LOD (20 ppm)	16,400	9,500	14,600	7,200	47,800	56	41	43	51	48
GE 50 ppm	10,600	2,600	3,900	3,500	20,600	36	11	12	25	21
GE 200 ppm	3,400	0	1,500	1,300	6,200	12	0	5	9	6
GE 400 ppm	1,800	0	300	0	2,100	6	0	1	0	2
GE 1,200 ppm	0	0	300	0	300	0	0	1	0	0
GE 1,600 ppm	0	0	300	0	300	0	0	1	0	0
GE 2,000 ppm	0	0	300	0	300	0	0	1	0	0
GE 5,000 ppm	0	0	0	0	0	0	0	0	0	0
Missing	0	0	600	0	600	0	0	2	0	1
No Soil in Play Area	6,600	6,100	8,600	2,100	23,400	23	27	26	15	23
No Play Area	1,600	1,200	800	500	4,100	5	5	2	3	4
Total	29,200	22,900	33,800	14,100	100,000	100	100	100	100	100

Percentage is number of centers as a percent of all centers in the construction year category

Values may not add to the total due to rounding

GE = Greater than or equal to

Table 6-4 presents the number and percentage of centers by construction year for selected soil lead concentration thresholds for bare soil only. As seen above for all soil, there is too little data to observe any trends.

Table 6-4. Distribution of soil sample (bare soil only) lead concentrations by construction year

Bare Soil Lead	Number of Centers					Percent of Centers				
Concentration	Before	1960 to	1978 to	Unknown	All Centers	Before	1960 to	1978 to	Unknown	All
Concentration	1960	1977	2001	Ulikilowii	An Centers	1960	1977	2001	Clikilowii	Centers
GE 0 ppm	21,000	15,200	21,900	10,300	68,400	72	66	65	73	68
GE LOD (20 ppm)	16,400	9,000	13,400	7,200	46,000	56	39	40	51	46
GE 50 ppm	10,600	2,100	3,900	3,500	20,200	36	9	12	25	20
GE 200 ppm	3,400	0	1,500	1,300	6,200	12	0	5	9	6
GE 400 ppm	1,800	0	300	0	2,100	6	0	1	0	2
GE 1,200 ppm	0	0	300	0	300	0	0	1	0	0
Missing	0	0	600	0	600	0	0	2	0	1
No Bare Soil	0	500	1,800	1,300	3,600	0	2	5	9	4
No Soil in Play Area	6,600	6,100	8,600	2,100	23,400	23	27	26	15	23
No Play Area	1,600	1,200	800	500	4,100	5	5	2	3	4
Total	29,200	22,900	33,800	14,100	100,000	100	100	100	100	100

Percentage is number of centers as a percent of all centers in the construction year category

Values may not add to the total due to rounding

GE = Greater than or equal to

Table 6-5 presents selected parameters of the distributions of soil lead concentrations. Table 6-5 also presents geometric means and standard deviations. As with the distributions of paint lead

loadings and dust lead loadings, the distribution of soil lead concentrations is right-skewed. Thus, a normal distribution would not be a suitable model for the distribution. A log-normal distribution would be a more suitable distribution.

Table 6-5. Estimated empirical distribution parameters of soil lead concentrations

	Play Area
	ppm
Arithmetic Mean	81
Arithmetic Standard Deviation	329
Geometric Mean	28
Geometric Standard Deviation	3
25th Percentile	15
Median	28
75th Percentile	53
90th Percentile	124
95th Percentile	219
Maximum	3,582
Number of Samples	122

For these calculations, zero values were replaced by 5.0.

#### 6.2 Association between Bare Soil Lead and Exterior Paint Condition

Table 6-6 shows the association between bare soil lead concentration and the condition of the exterior LBP. Higher bare soil lead concentrations occur for centers with significantly deteriorated exterior LBP. An estimated 17 percent (10% to 27%) of centers with intact or minimally-deteriorated exterior LBP have bare soil lead above 50 ppm, while 46 percent (16% to 79%) of centers with deteriorated exterior LBP have bare soil levels above 50 ppm. Only 2 and 0 percent of centers without significantly deteriorated exterior LBP have bare soil lead levels above 200 and 400 ppm, respectively, while 39 and 16 percent of centers with deteriorated exterior LBP have bare soil lead levels above 200 and 400 ppm, respectively.

Table 6-6. Association between bare soil lead concentration and presence of significantly deteriorated exterior LBP

Bare Soil Lead		without Sign rated Exteri	-	Centers with Significantly Deteriorated Exterior LBP			
	Percent	Lower 95% CI	Upper 95% CI	Percent	Lower 95% CI	Upper 95% CI	
GE 0 ppm	68	58	77	68	35	90	
GE LOD (20 ppm)	45	37	54	52	20	83	
GE 50 ppm	17	10	27	46	16	79	
GE 200 ppm	2	1	5	39	11	76	
GE 400 ppm	0	0	2	16	4	42	
GE 1,200 ppm	0	0	2	0	0	4	
Missing	1	0	4	0	0	4	
No Bare Soil	3	1	7	11	2	49	
No Soil in Play Area	24	16	35	18	5	47	
No Play Area	4	2	9	3	0	16	
Total	100			100			

CI = Confidence limit for a 95% confidence interval for the estimated number or percent

Values may not add to the total due to rounding

Percentages use 99,952 centers as the denominator

GE = Greater than or equal to

### 6.3 Comparison of Soil Lead Hazard Prevalence Between Child Care Centers and Homes

Soil lead hazards are found more often in homes than in CCCs. An estimated two percent (one to six percent) of CCCs have soil lead hazards. In comparison, 10 percent (7 to 14 percent) of homes were found to have soil lead hazards. Due to the small number of CCCs with a soil lead hazard, more detailed comparisons are not possible.

### 7. QUALITATIVE SUMMARY OF SOURCES OF ERROR

Chapter 7 examines the quality of the data and the resulting quality of projected national estimates. The greatest source of error in the First National Environmental Health Survey of Child Care Centers (referred to here as the CCC Survey) estimates is sampling error—as discussed in Volume III, Chapter 2. This chapter addresses two additional important potential sources of error – nonresponse bias and measurement bias—and discusses their effects on the national estimates of the prevalence of lead-based paint (LBP), lead in dust, and lead in soil.<sup>1</sup>

The chapter concludes with a summary of the data collection quality assurance activities, including results of telephone verification, field team audits, field dust and soil quality control samples, laboratory performance on dust and soil quality control samples, and paint testing quality control.

# 7.1 Statistical Concepts and Terminology

There are two broad types of error in survey estimates: sampling error and nonsampling error.

- Sampling Error. Sampling error arises from surveying a random sample rather than a complete census of all centers. It is a function of the sample size and sample design. Different samples of the same size drawn using the same sample design will yield varying estimates of the population parameters. This variation about the true population parameter is the sampling error.
- Nonsampling Error. Nonsampling errors arise from a number of sources including differential response rates from different demographic groups, types of centers, and geographical areas; unknown differences between the respondents and nonrespondents; differences between the sample frame and the target population; some types of processing and data reduction techniques; and classification bias due to measurement error inherent in XRF and laboratory instrumentation and variation in a measured parameter across a surface and among rooms.

Throughout the report, the term *weight* has been used in conjunction with the sampled centers and rooms. It is important that these terms be understood.

<sup>&</sup>lt;sup>1</sup> Another source of error in the survey is response bias (i.e., how correct was the information provided by the respondents?). Significant information obtained from respondents included year of construction of the building. These data are thus associated with an unknown amount of error. These data were partially verified by other means to help control any error (see Volume III for details).

- Center Weight: The center weight is the number of centers in the target population that a single center in the survey represents. The weight is calculated by taking the inverse of the probability of selection for that unit. Thus, if the probability of selection is 0.01, the sample weight is 100. With multistage samples, the overall probability of selection is the product of the conditional probabilities of selection at each stage.
- Room Weight: The room weight is the number of rooms in the target population that a single room in the survey represents. Room weights were determined by dividing the center weights by the probability of room selection based on the inventory of all rooms used by children under age 6 in each center. A nonresponse adjustment was then made to account for noncompleted rooms. A room was only considered to be complete if some environmental samples and data were collected in the room.

#### 7.2 Potential for Nonresponse Bias

Completion rates were calculated as the unweighted proportion of sampled centers that completed data collection or were found to be ineligible. Of the 334 centers sampled, 168 completed data collection and 68 were found to be ineligible. The remaining 98 did not complete the data collection, but were determined to be eligible. The completion rate for the survey was 70.7 percent.

The formula for the unweighted completion rate is given below along with the eligibility rate and response rate.

Completion Rate = 100% x 
$$\frac{\text{\#completes + \#ineligible}}{\text{\#fielded}}$$
 = 100% x  $\frac{168 + 68}{334}$  = 70.7%

Eligibility was determined for all fielded cases. Nonrespondents were asked enough questions to determine their eligibility. The eligibility rate was 79.6 percent.

Eligibility Rate = 100% x 
$$\frac{\text{# eligible}}{\text{# eligible}} = 100\%$$
 x  $\frac{266}{266 + 68}$  = 79.6%

The response rate measures the response among eligible CCCs. The response rate for the survey was 63.2 percent.

Response Rate = 
$$100\%$$
 x  $\frac{\text{\# eligible completes}}{\text{\# eligible completes}} = \frac{100\% \text{ x}}{168 + 98} = 63.2\%$ 

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The weights are constructed to weight the responding CCCs up to the total population. The weights adjust for nonresponse based on the assumption that, within groups of similar CCCs, the respondents are similar to the nonrespondents. The estimates calculated using the weights might be biased if this assumption is incorrect.

In addition, the weights are calculated assuming that the population is not changing over time. However, CCCs open and close over time and the state lists of CCCs (from which the centers were sampled) may not be up to date. This can create additional uncertainty in the estimates that is not reflected in the confidence intervals.

# 7.3 Correcting for Classification Bias Due to Measurement Error

Centers were classified as having LBP and lead hazards based on the XRF readings of paint and the analysis of dust and soil samples. Random variation associated with instrument or laboratory measurement, sample collection, and random selection of sampling locations can induce a classification bias resulting in a bias in the estimated prevalence of centers with LBP and lead hazards. As a general rule, small percentage estimates will overestimate the true percentage of centers and large percentage estimates will underestimate the true percentage. This can be illustrated using the following hypothetical example. Assume that, within a group of centers, 2 percent have a soil lead hazard and 98 percent do not. Also assume that on average one percent of the centers are misclassified due to measurement error. The expected percentage of centers classified as having a soil lead hazard based on the observed measurements is the sum of (1) the centers without a soil lead hazard that are misclassified as having a soil lead hazard and (2) the centers with a soil lead hazard that are correctly classified. The relevant calculations are shown in the Table 7-1. Due to misclassification, three percent of hypothesized centers are classified as having a soil lead hazard when only 2 percent actually have a soil lead hazard. Similarly, 97 percent are classified as not having a soil lead hazard when 98 percent actually do not have a soil lead hazard.

Table 7-1. Effect of measurement error on the percentage of centers (hypothetical example, assumes 1% misclassification rate)

T C-:1	D	According to			
True Soil	Percent of	Measurements			
Hazard	Centers	Yes	No		
Yes	2%	1.98%	0.02%		
No	98%	0.98%	97.02%		
Total	100.0%	2.96%	97.04%		

In the survey data, 2 percent of CCCs are estimated to have soil lead hazards. Because the soil measurements have measurement error, the true proportion of CCCs with soil lead hazards is more likely to be less than 2 percent than greater than 2 percent. Similar statements apply to the percentage of centers with dust lead and paint lead hazards. Estimates of the variance of the data and the variance of the measurement error suggest that the bias in the number and percentage of centers with soil and dust hazards is likely to be small. Rough estimates of the bias for classifying CCCs with LBP are difficult to calculate and have not been obtained.

In addition, paint and dust measurements were made in a sample of rooms—not all rooms. Under this protocol, it is possible for a center to have LBP or a LBP dust hazard in an unsampled room. When no lead-based paint and/or no dust-lead hazard is found in the sampled room such centers would be incorrectly classified as not having LBP and/or LBP hazards (false negatives). Assessing the effect of incomplete sampling of rooms on the percentage of centers with LBP and dust lead hazards is difficult. However, a conservative estimate (based on the fact that approximately half of all rooms were sampled) is that the true percentage of centers is no greater than twice the estimated percentage for small percentages.<sup>2</sup> Since the percentage of centers with LBP or dust hazards is relatively small, the bias due to sampling and measurement error and the bias due to incomplete sampling of rooms will tend to cancel each other out. As a result, bias in the number and percent of centers with LBP and dust hazards is expected to be small compared to the width of the confidence intervals.

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<sup>&</sup>lt;sup>2</sup> Among centers with a hazard, if the hazard is in only one room and half of all rooms are sampled then the estimated number of centers in which a hazard is identified will be half the actual number. Since centers with a hazard in one room are likely to have a hazard in other rooms, the true number of centers with a hazard will be less than twice the estimated number.

# 7.4 Quality of Field Data Collection and Analysis for Lead Samples and Measurements

Quality assurance was integrated into all components of the study including a defensible study design; experienced project personnel; utilization of well-planned, detailed, and tested protocols for all aspects of data collection; thorough study-specific training of experienced field staff; electronic sample and data management; and ongoing communication between individuals responsible for each stage of the study. These procedures are described in detail in Volume III, Chapter 6.

#### 7.4.1 Field Data Collection

A number of procedures were instituted to ensure quality of the field data collection including a manual edit of all data and samples by the field team, review by the field supervisor upon return of the data to Westat headquarters, and reconciliation of any errors with the field team prior to submission of any samples to the laboratory. In addition, random telephone verification and field team audits were conducted, dust sample material screens were analyzed, and dust blanks and spike samples and blind soil reference samples were included in the sample stream.

#### **Telephone Verification of Data Collection**

The telephone interviewers contacted each center director by telephone to verify the team's activities and conduct and to validate selected information from the data forms. No problems associated with sample or data quality were reported.

# **Random Field Audits**

The Quality Assurance Officer or designee, and the U.S. Department of Housing and Urban Development (HUD) and the U.S. Environmental Protection Agency (EPA) representatives conducted random field audits at 13 centers to verify that the protocols were followed and data collection was accurate and complete. Problems noted during these audits were corrected directly with the individual technicians. In addition, the results of audits were immediately relayed to the field office. As appropriate, all field staff were notified by memorandum of any issues identified with the protocols.

# **Lead Dust Wipe Sample Collection**

- Lead Dust Wipe Materials Screens. The purpose of a materials screen (or lot blank) was to verify that the various sampling supplies to be used in the field did not have lead contamination. Two screens were prepared and analyzed for every lot of wipe materials and sample tubes before being used in the study. The analyses showed that all material screens had less than 1.5 μg lead.<sup>3</sup>
- Field Blank Wipes. One field blank wipe was prepared for each center at a specified random sample location where a wipe sample was collected. All field blanks were below 4.2 μg lead/wipe. In fact, the majority (143 samples) had less than 1.0 μg lead/wipe.
- Reference (Spike) Sample Dust Wipes. Reference wipe samples were made in advance of the fieldwork by placing a known quantity of National Institute of Standards and Technology's Standard Reference Material (NIST SRM) 1579a on the same wipe material used in the study. The reference wipes were labeled like a regular sample so that the laboratory was blinded to fact that these were quality control samples. The Field Office inserted one reference wipe sample with each group of 50 samples before sending samples to the laboratory. A total of 15 reference wipes, ranging from 28 to 316 μg lead/wipe, were submitted. The average reference sample recovery was 93 percent (range from 88% to 98%).

#### **Soil Quality Control Samples**

■ **Reference Soil Samples.** Reference soil samples were urban soil provided by the University of Cincinnati (one sample with 640; two samples with 3,132; and one sample with 6,090 ppm lead). The Field Office labeled and included one reference sample with each group of 50 samples. The average recovery was 111 percent (range 110% to 112%).

#### 7.4.2 Laboratory Quality Control Samples

Each laboratory provided quality assurance procedures during the selection and qualification process. These approved procedures (outlined in the CCC Survey's Protocol and Sample Design Report, December 2001) were adhered to for all study samples. In general, the laboratories performed instrumental and duplicate quality control analyses, as required by ASTM E 1613-94 and the American Industrial Hygiene Association's Environmental Lead Laboratory Accreditation Program (ELLAP) Quality Manual and Policies, to ensure that the original calibration solutions were accurate, the instruments were properly zeroed, instrumental drift was not excessive, and carryover between samples

<sup>&</sup>lt;sup>3</sup> EPA's National Lead Laboratory Accreditation Program (NLLAP) requires wipes to be used in the field to have less than 5 µg lead/wipe.

<sup>&</sup>lt;sup>4</sup> No appropriate soil standards with lower lead concentrations were available.

did not occur. These included duplicate injections of the same sample, method blanks, and spiked samples at a minimum frequency of five percent of the samples.

#### 7.4.3 Laboratory Selection Quality Assurance

The laboratories used for analysis of dust and soil samples, respectively, were recognized by the EPA under its National Lead Laboratory Accreditation Program (NLLAP) for those analyses throughout the laboratory qualification and performance phases of the CCC Survey. This recognition provided assurance of the quality of laboratory performance of lead analyses and reporting. In addition, the laboratories were accredited by the American Industrial Hygiene Association; this accreditation provided a separate assurance of the quality of laboratory management and performance of environmental analyses and reporting.

### 7.4.4 Paint Testing Quality Assurance

Calibration of the XRF analyzer was performed before and after testing in every center. In no case was the instrument used if the calibration criteria were not met; that is, the analyzer read 0.0 mg/cm² on the 0.0 film and between 0.9 and 1.2 mg/cm² on both the front and back of the 1.0 film. In addition, the average of three more readings on the front of the 1.0 film was between 0.9 and 1.2 mg/cm².

The calibration of the XRF instruments was checked before and after making XRF paint lead measurements at the CCC. The calibration procedures were as follows. If the instrument did not pass the first calibration check, the calibration was checked a second time. If the second calibration was not within the desired limits the instrument was turned off and turned back on and the calibration was checked a third time. If the instrument failed the third calibration the instrument was not used until it was checked and/or repaired. If the instrument passed the third calibration it was considered properly calibrated and was used for paint testing.

For each calibration check, HUD requires that a sequence of three measurements on the 1.0 mg/cm² calibration film have an average reading between 0.9 and 1.2 mg/cm² inclusive. The XRF manufacturer recommended also testing the back of the 1.0 mg/cm² film and checking a 0.0 mg/cm² film. The survey procedures included these recommended tests. The third calibration check was required in only one case and the instrument passed that calibration check. In no cases did the instrument fail the third calibration check or require additional checking or repair. However, in 16 of 345 calibrations the calibration information was not taken or recorded according to the survey procedures. In 11 cases the

first calibration check passed the HUD calibration criteria but not the manufacturer's recommended tests and a second calibration check was either not performed or not recorded. In one case the second calibration check passed the HUD calibration criteria but not the manufacturer's recommended tests and a third calibration check was either not performed or not recorded. In four cases the first calibration did not pass the HUD calibration criteria but did pass the manufacturer's recommended tests and a second calibration check was either not performed or not recorded. Whether the instrument failed calibration check was based on the information written on the XRF calibration form. In several cases the instrument was judged to fail the calibration check because some lines on the form were not completed. In these cases the calibration procedure may have been completed without having all the information entered on the form.

After reviewing the calibration data and the XRF measurements at the centers where there was a problem with the calibration procedure, no problem was found that suggests that the XRF data for those CCCs with calibration problems are not as good as the data from other centers.